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M1 Tank Driver Tests

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The purpose of this research was to develop reliable tests of non-procedural M1 tank driver skills that could serve as quantitative measures for tank-driver performance in simulators. Eleven driving tasks were derived from an Army Research Institute criticality survey. Analysis of the tasks resulted in decisions to test nine of the tasks, but only those aspects that related to the driver and were feasible for testing. The tests were tried out on 77 soldiers in two M1 OSUT classes. The data were used to assess scorer agreement and internal consistency, to estimate (Continued)

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validity and utility based on reliability and variability and to direct revisions and recommendations for future testing. For each of the nine tests, the data indicated that driver performance could be measured reliably. Tests were designed so that usable quantitative data could be obtained. Although refinements and broader applications of the tests are required, the tests should serve the purpose for which they were designed.

Research Report 1391

M1 Tank Driver Tests

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Mission-Based Simulation
and Training Requirements

ARI Research Reports and Technical Reports are intended for sponsors of R&D tasks and for other research and military agencies. Any findings ready for implementation at the time of publication are presented in the last part of the Brief. Upon completion of a major phase of the task, formal recommendations for official action normally are conveyed to appropriate military agencies by briefing or Disposition Form.

FOREWORD

The Automated Training Technology team of the Army Research Institute for the Behavioral and Social Sciences (ARI) performs research in areas that include the use of simulators and devices in military training. Of special interest is research in the area of evaluating simulators and devices in terms of transfer of training to the actual weapon system. In order to do this, however, specific objective tests of MOS skills must have been developed with criterion performance measures set.

This report provides reliable tests of non-procedural M1 tank driver skills that could serve as quantitative measures for tank driver simulator training. The tests could also be of service to the Army for the determination of how well soldiers perform the different skills that are required during tank driver training and if skills are performed to standard. The Army is currently organizing to train for NBC and extended operations maneuvers. The driving tests would be of value for the measurement of perceptual degradation affecting performance over time for the tank driver. The identified parameters which cause performance degradation can help structure training methods for the alleviation of the specific NBC and extended operations problems.

Further testing and evaluation of the developed M1 Tank Driver Tests will lead to the determination of criterion performance measures against which simulation tests can be compared. The criterion performance measures will yield a set base line for use in evaluation of tank design concepts for futuristic tank warfare by the U.S. Army Tank Automotive Command Tank Test Bed Program and Future Close Combat Vehicle Programs.

EDGAR M. JOHNSON
Technical Director

ACKNOWLEDGMENTS

This report deals with the testing of M1 tank drivers, focusing on the requirement to establish reliable measures of nonprocedural portions of the tank driver's job. The work was required under Task 21, Field Driving Test Situations for M1 Drivers, which was performed for a project entitled, "Mission-Based Simulation and Training Requirements." Mr. Eugene H. Drucker is the project director.

The work was conducted by the Human Resources Research Organization (HumRRO) under Contract No. MDA 903-80-C-0223 with the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI). It was performed at the Fort Knox, Kentucky office of HumRRO's Training Research Division, Mr. William C. Osborn, Director. Dr. Donald M. Kristiansen was the Contracting Officer's Representative.

A HumRRO staff member who contributed significantly to this work was Mr. Patrick Ford. Other HumRRO staff who worked on the project were Bridgette O'Brien, Eugene Drucker, Richard O'Brien and Richard Woods.

ARI personnel who assisted in the project were Merle Allen, Michael Anderson, and SP5 Leonard Cardwell. Major Robert Harold, ARI R&D Coordinator, made arrangements for troop support.

CPT Kurt Bielefeld and CPT Ralph Hill, commanders of Company C and Company B, 1st Battalion, 1st AIT/OSUT Brigade, Armor, and the non-commissioned officers of those units provided scorers, reviewers, equipment, administrative and troop support for the field tests.

M1 TANK DRIVER TESTS

EXECUTIVE SUMMARY

Requirement:

Develop and assess the reliability of quantitative, on-tank tests of nonprocedural, tactical M1 tank driving skills.

Procedure:

Eleven driving tasks for which tests were to be developed were derived from an ARI criticality survey. Analysis of the task resulted in decisions to test nine of the tasks, but only those aspects that related to the driver and that were feasible for testing. Five of the tests were Obstacle/Judgment tests, and four were Tactical tests. The tests were tried out on 77 soldiers in two M1 OSUT classes (none of the soldiers took all the tests). The data were used to assess scorer agreement and internal consistency, to estimate utility based on reliability and variability, and to direct revisions and recommendations for future testing.

Findings:

For each of the nine tests, the data indicated that driver performance could be measured reliably. Both the Obstacle/Judgment tests and Tactical tests had been designed so that usable quantitative data could be obtained, and for every test, refinements were suggested based on data and on informal observations. For two of the Tactical tests, an innovative scoring technique using an M1 tank profile overlay was explored. Despite high ratings in the criticality survey, one Obstacle/Judgment test was recommended for deletion.

Utilization of Findings:

While more replications and developmental refinements of the tests are needed, the analysis and development performed have produced tests that are already minimally reliable. The tests were designed for use in measuring on-tank driving performance against which to assess driver simulator training. They may also be useful in general field applications for training.

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INTRODUCTION

The potential requirement to fight outnumbered has created need for more effective training in today's Army. But high training costs, lack of sufficient training time, shortages of training areas, and high crew turnover rates have made the training manager's task very difficult. Several training innovations have been introduced and others are planned to help overcome the consequences of these problems. Among these are the development of new simulators and training devices, and specialized training for specific MOS related to particular weapon systems.

Among the simulators and trainers being developed is one for training drivers of the M1 (Abrams) tank. The trainer is to cover nonprocedural tactical driving situations. Nonprocedural tasks are characterized by the fact that while the tasks remain constant, the conditions under which they are performed or the cues to which the soldier may respond are variable to a degree that it may be impossible to address all variations within a single analysis. To evaluate the training effectiveness of the device, quantitative and objective measures for assessing actual tank driving performance on the M1 tank are needed to serve as criteria. The first steps toward development of the measures were to examine the existing driver tests and determine the criticality of nonprocedural M1 tank driving subtasks.

The present method for training tank crewmen during One Station Unit Training (OSUT) requires that soldiers pass a series of performance tests before proceeding to the next phase of OSUT training. While the tests contain comprehensive coverage of tasks dealing with the preparation of the driver's, gunner's and loader's stations, they do not contain comprehensive tests of tank driving skills. Training Site Certification (TSC) is generally used to assess driving skills. During TSC, soldiers are required to drive tanks in daylight over a designated course consisting of a paved track over level terrain. Measures consist of Pass/Fail checklist items related to basic driving skills (turns, acceleration and stopping, smoke generator operation). The course must be completed within 30 minutes.[1]

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[1]This TSC course descripton is as of May 1982. M1 OSUT driving is an area of emphasis and the TSC is subject to change in content and duration with subsequent OSUT classes.

Classroom instruction in OSUT presents information on tactical driving (e.g., selection of routes and positions) but TSC offers the only actual driving opportunity for the trainees. Unless resources (e.g., fuel and tanks) increase substantially, this limitation on driving is likely to continue. While TSC involves verification by a trainer that a soldier has received driver training and has, in fact, driven a tank, it contains no provisions for testing how well soldiers can perform the different skills that are required during tank driving, nor does it result in a quantitative measure that can be used to determine whether or not the skills can be performed to standard.

Tank driving skills are developed in the unit and, correspondingly, tests are developed for assessing driving in the unit which cover skills more advanced than the OSUT test. Driving mastery and readiness tests have been developed for the M48 (Baker and Roach, 1960) and M60A1 tanks (O'Brien, Harris, Osborn, and Healy, 1979; Eaton, Bessemer, and Kristiansen, 1979). Like the OSUT tests, these readiness tests require subjective ratings (Pass/Fail scores on checklists) of the driver's ability to perform a series of steps or characteristics of the driving tasks.

Table 1 summarizes the driving activities in the tests. In general, the OSUT test contains more of the basic skills and the tests by O'Brien et al. and Eaton et al. contain more of the advanced, tactical skills such as driving during engagements.

The research by Eaton et al. reports the development of the driving tests and their use as criterion measures. Eaton et al. examined the use of aptitude tests, other pencil and paper measures, and OSUT measures to predict driving skills. Since no generally accepted measures existed for tactical driving skills, they developed a driving course and performance measures. As a starting point, they used a driving course checklist from Greenstein and Hughes (1976) and augmented it with driving tasks selected by panels of NCO driving instructors. The final "Advanced Driving Checklist," designed for tank commanders (TC) to score drivers, contained the driving skills shown in Table 1.

Table 1

Driving Test Content

Driving Activities	Driving Tests				
	OSUT TSC	Baker & Roach	O'Brien et al.	Eaton et al. Basic	Eaton et al. Advanced
Drive the Tank					
Accelerate/maintain speed	X				
Turns	X	X			
Stop	X	X		X	
Back straight	X	X		X	
Varied/natural terrain			X	X	
Operate smoke generator	X				
Drive over an obstacle	X[a]	X	X		
Drive across a ditch	X[a]	X	X		
Drive up/down steep hill	X[a]	X	X		X
Follow hand/arm signals		X		X	
Perform evasive maneuvers upon enemy contact			X		
Drive into defilade firing position upon enemy contact			X		
Drive in response to fire commands					
Coax area target			X		X
.50 cal. area target			X		
Halt for coax point target			X		
Halt for .50 cal. point target			X		
Halt for main gun target			X		X
Flank moving coax engagement					X
Main gun engagement-hull defilade					X
Main gun engagement-from road					X
Main gun engagement					X
Acquire targets			X		
Observe/sense rounds			X		
Starting/stopping procedures				X	
Operate amplifier audio frequency				X	
Operate intercom control				X	
Radio check				X	
Ground guide--give hand/arm signals				X	
Drive buttoned up				X	
Drive on paved road				X	

[a]In May 1982 the TSC driving location did not fully support evaluation of these activities.

In their next research phase, Eaton et al. more strongly emphasized tactical driving. They developed measures in which the TC rated the trainees' overall driving skills on a seven-point scale and completed a checklist. The checklist items set forth the TC role and potential driver responses (e.g., "Main gun engagement. When TC instructs driver to find defilade position and issues fire command does driver . . ."). The tactical situations were: main gun engagement, moving coax engagement, ditch crossing, main gun engagement from hull defilade position, main gun engagement from road, and flank moving coax engagement.

Eaton et al. noted the problems of rater reliability in the use of observational ratings and checklists, but their design did not permit direct assessment of reliability. The current research extends the development of tactical driving criterion measures to the assessment of reliabiity.

Objective

The overall goal of the research is to design measures of driving skills, using quantitative scoring techniques which can be implemented by Army personnel. The quantitative measures will focus on the underlying continuous perceptual motor skills, perceptual judgments, and decision-making critical to performance of driving tasks. Specifically, the objective is to develop and assess the reliability of quantitative, on-tank tests of nonprocedural, tactical M1 tank driving skills. The purpose of the effort is to develop criteria against which driver simulator performance can be compared.

METHOD

Task Selection

Initial selection of tactical skills was based on a criticality assessment questionnaire developed and administered by the Army Research Institute (Burroughs, 1981).

Driving subtasks were listed in a questionnaire which asked M1 drivers to rate the subtasks on three dimensions of criticality: driving practice time needed to become skillful, importance to accomplishing assigned combat missions, and consequences of inadequate performance. The criticality dimensions were chosen from the Training Development Handbook Phase I: Analysis, a description of instructional systems development procedures for use by the U.S. Army Armor Center, (April 1978). These procedures are based on the Interservice Procedures for Instructional Systems Development described in the five-volume TRADOC Pamphlet 350-30. Although the major concern of the Research was to determine which driving skills were critical to accomplishing assigned combat missions, it seemed logical to view this dimension in relation to both learning difficulty and consequences of inadequate performance. Consequences of inadequate performance are those which result in injury to personnel, loss of life, or damage to the tank. The three dimensions taken together estimate the importance of simulating these skills on a training device. If, for example, the skill is critical to accomplishing assigned combat missions, but is learned rapidly and has negligible consequences if performed inadequately, it might not be cost-effective to simulate conditions for practice of the skill on a low-cost device. The low-cost device is best used and most cost-effective for critical skills that are difficult to learn (require much repetition) and have extremely serious consequences if performed inadequately.

The most valid evaluation of which tank driving subtasks are critical is made by non-commissioned officers with M1 tank driving experience. Twenty-five non-commissioned officers, 2/6 Cavalry and 1/1 AIT OSUT Brigade, including M1 tank instructors at Fort Knox and thirty-five non-commissioned officers, 2/67 Armor, with unit driving experience from Fort Hood, rated the subtasks for the evaluation. After filling out the

questionnaire, each NCO was interviewed to determine both adequate and insufficient training he had received on the various M1 driving skills. The soldiers were also queried as to the level of decision-making a driver is expected to execute during combat situations, and what level of decision-making he was trained to do and does in unit driving.

Based on those results, 11 tasks were identified as candidate tasks for testing:

- o Pass Under Overhead Obstacle
- o Negotiate Narrow Passage
- o Maintain Steady Firing Platform
- o Minimize Exposure Time in Open Terrain
- o Turn Glacis Toward Greatest Threat
- o Drive Up/Down Inclines (Under 31 Degrees)
- o Drive On Side Slopes (Under 22 Degrees)
- o Perform Missile Evasive Maneuvers
- o Load Tank on Rail Car
- o Respond To TC Maneuver Directions
- o Perform Pop-Up Firing Technique

This task listing was to provide the nucleus of critical skills around which testing would focus. The emphasis in the test development was to be on quantitative criterion measures and reliability. There were four main phases to accomplish this goal:

- o Initial Test Development
- o Developmental Tryouts
- o Test Revision
- o Testing

Initial Test Development

Initial test development involved two steps:

1. Analysis of tasks selected
2. Development of scoring instruments

Step 1. Analysis of Tasks Selected. The position of the tank driver is probably the poorest defined of all the crew positions. Procedurally, the actions of the driver are simple--starting, stopping, accelerating, braking, etc.--but operationally his skills become complex and are not well documented. The driver of a tank does not occupy a role that is operationally separate from the rest of the crew. Interaction with other crewmembers, particularly the tank commander, is constant and ultimately the tank commander is responsible for the speed, direction and movement of the vehicle. The situation is confused by the fact that there are many variations in driver responsibilities from crew to crew and the experience of the driver and the expectations of the tank commander dictate how much independent driver action is allowed or expected. A further complication is that the driving requirements of most tactical tasks are extremely situational and, while driving procedures can be identified, the sequence, interactions and execution of those procedures are difficult if not impossible to delineate except in the context of a specific situation.

The tasks selected from the ARI questionnaire did not include any detailed description defining the scope of the activity involved. Therefore a separate analysis step was required before test development.

The 11 tasks originally selected were divided into two groups, i.e.:

Tactical	Obstacles
Minimize Exposure Time in Open Terrain	Load Tank on Rail Car
Perform Missile Evasive Maneuvers	Negotiate Narrow Passage
Maintain Steady Firing Platform	Pass Under Overhead Obstacles
Perform Pop-Up Firing Technique	Drive on Side Slopes (Under 22 Degrees)
Turn Glacis Toward Greatest Threat	Drive Up/Down Inclines (Under 31 Degrees)
Respond To TC Maneuver Directions	

An informal analysis of each task was performed using available literature and knowledge of the task. The analysis was conducted with a view toward testing primarily with conventional measurement means; i.e., observation.

The analysis of the tactical tasks confirmed the ambiguity of the driver's role and the team-task nature of the performances. To more accurately define the driver's role in many of the listed tasks it was determined that a much more detailed analysis of the crew performance would be required using team-task analysis. Additionally, the preliminary analysis identified a variety of performances possible under the identified Tactical tasks. For example:

- Perform Missile Evasive Maneuvers. Three types of performances are possible--Duck, Dodge or Zig Zag--depending on the circumstances of the missile engagement. Further, the three performances can occur separately or in conjunction with each other. While Zig Zag is the most common it is also the most demanding in terms of vehicle risk and terrain requirements.

- Perform Pop-Up Firing Technique. The nature of the task changes, depending on whether the task is performed in conjunction with a deliberately prepared defensive position, a hasty defensive position, or as an offensive firing technique. Further, the task is most often performed in conjunction with other tanks in the section. In some situations the primary responsibility and skill lie with the gunner, not the driver. Tactically it is often a preplanned or rehearsed activity.

- Respond To TC Maneuver Directions. As a task this is totally dependent on the situational conditions. In fact, it is probably not a separate task but is an inherent part of most tactical tasks.

- Turn Glacis Toward Greatest Threat. This is dependent on terrain, threat and other ongoing required tank activity. It is generally performed as part of maneuver, not firing, and is a technique incorporated in other tasks rather than a separate task. Implied in the task statement ("greatest threat") is a driver judgment of multiple threat capability--a difficult and complex requirement.

- Minimize Exposure Time in Open Terrain. This activity is dependent on terrain, threat, tank missions and surrounding activity to include section/platoon actions and

support available. The responsibility for route selection, route correction and selection of positions lies primarily with the tank commander. In many situations, and particularly for novice drivers, the driver's responsibility is in execution, not selection.

- Maintain Steady Firing Platform. As a driver task, this is highly dependent on the training and expectations of the crew. Emphasis is on eliminating or minimizing anything that would interfere with the gunner actions but this is highly dependent on the terrain and other tactical conditions, including the type of fire being delivered (assault, suppressive, precision). Requirements are most often expressed in ambiguous terms such as "smooth," "steady," "even," and "avoid unnecessary obstacles," which are given without standards or further usable definition. The skill of the gunner, duration of the engagement, expected outcome of the engagement and support available all affect the driver requirements and it is difficult to isolate the specific driver responsibilities, much less define them for observer measurement for test purposes.

The analysis of the Obstacle tasks revealed that the tasks were not as definitive as they first appeared:

- Load Tank on Rail Car. Essentially a ground guide task; in fact, the positioning and control of the tank are entirely the ground guide's responsibility. The driver must merely follow the ground guide signals. The psychological implications of knowing that he (the driver) can fall off the platform and the movement of the platform itself are the biggest factors that affect the driver. In testing, these are difficult to simulate. (It was assumed that actual flat cars would be unavailable for testing.)

- Negotiate Narrow Passage and Pass Under Overhead Obstacles. These tasks are rarely performed unassisted and in the case of Negotiate Narrow Passage is, in extremely close situations, performed with a ground guide, removing any responsibility or judgment from the driver. Ultimately decisions on passing these obstacles lie with the tank commander. This is especially true of passing overhead obstacles where the TC (or loader) is in a better physical location to judge clearance. Passage under overhead obstacles is also dependent on conditions. "Soft" obstacles such as tree limbs can be negotiated with less risk than hard obstacles such as overpasses. Height requirements also vary with the nature of the obstacle. An overpass that will strike the antenna presents no risk but an electrical line within antenna height presents a high risk situation.

- <u>Drive on Side Slopes of 22 Degrees and Drive Up/Down Inclines of 31 Degrees</u>. The 22 degree slope and 31 degree incline capabilities of the M1 tank are theoretical capabilities. Under field conditions the climbing capability of the M1 is dependent on the propensity to shear soil off the rear and sides of the track. This propensity is a factor of both the vehicle and the type (sandy, clay, gravel) and condition (wet, moist, dry) of the soil. To determine the potential ability of the M1 to navigate any given uniform slope it is necessary to determine the M1 Vehicle Cone Index (VCI) and the soil Rating Cone Index (RCI). RCI is determined by performing a soils test under the expected navigation conditions (wet, moist, dry). Applying the RCI and VCI to performance curves can then determine the maximum ascendable slope. This would change somewhat during testing, however, if the same "track" were repeatedly used. It was assumed that for testing purposes it would be necessary to find a slope or series of slopes that would demand the maximum capability of the vehicle in order to judge driver skill by his ability to navigate it successfully. In other words, the slope should be passable but not "easily" navigated. The preparation for such a test, while not impossible to accomplish, is nonetheless considerable. More importantly, there were no accessible inclines in the proposed test site area that approached the slope requirements.

Following the preliminary analysis, a meeting was held with the ARI task leader and project staff to discuss the findings of the analysis and decide on a preliminary approach to testing. As a result of this meeting it was decided:

- To forego team task analysis which might isolate driver requirements and allow driver testing in a crew context. The time required and uncertain results of team task analysis precluded this approach.

- To change the nature of the "task," where necessary, to test only those aspects that related to the driver and were feasible for testing. An important part of this decision was to name precisely what was being tested, which in most cases was not the same as the task listed. For example, Acceleration and Stopping could be tested instead of the task, "Perform Pop-Up Firing Technique." Acceleration and Stopping is contributory to Pop-Up Firing Technique but it is not the entire task nor, perhaps, even the most important part of the task. In some cases what resulted were not even tasks but rather behaviors or judgments related to tasks. An important point was in renaming the tests to avoid creating the impression that whole task performance was being evaluated where it was not.

- Not to be overly constrained by reality in deciding the behaviors to be tested; or, more precisely, to construct the test around situations that did not necessarily reflect realistic job situations. For example, the task, "Negotiate Overhead Obstacles," is realistically not performed without TC/loader interaction and assistance. By changing the task to a test of "Judging Overhead Clearance," the driver can be forced to make the decision on his own without contaminating what he has learned to do and what he is supposed to do in the actual job situation.

- To drop unfeasible tasks. Tasks such as those involving the 22 degree slope and 31 degree incline and the Exposure Time in Open Terrain are difficult to standardize in a test situation. Given the terrain available at Fort Knox for testing, they were completely impractical because of lack of requisite slopes and space and terrain requirements. Rather than change the test location, the tasks were dropped.

The result was a reordering and, in most cases, renaming of the tests. The tested behaviors were no longer referred to as "tasks" to avoid confusion with the existing full crew behaviors that are more rightly called tasks. The resulting tests were:

Tactical	Obstacle/Judgment
React To TC Command (Hull Defilade)	Judge Overhead Clearance
React To TC Command (Missile, Duck)	Judge Width Clearance
Drive Tank During Main Gun Engagement	Follow Ground Guide Signals
Acceleration and Stopping	

Step 2. Development of Scoring Instruments. Preliminary test development concentrated on producing scoresheets that focused on two areas; i.e.:

- Off-vehicle scoring
- Quantitative measurement

Off-vehicle scoring was desirable in order to facilitate determination of interrater reliability and to reduce reliance on the TC or other crewmember who is often distracted or preoccupied with his own role requirements during testing. Quantitative measurement was needed in order to establish a range of performance and to avoid dichotomous classification of

performance measures. The wide range of possible behavior and the eventual need to establish how much of this behavior could be captured in simulator performance were also determinants of the requirement for quantitative measurement.

Not all tests could be fully scored by such methods. Time measures were included in all instruments but this was the only universal quantitative measure. Some tasks (e.g., Judge Overhead Clearance) did not lend themselves to a single quantitative performance evaluation--the judgment was either correct or it was not. However, a series of judgment requirements could be introduced.

Some measure of performance from a remote or off-vehicle location was obtainable on all tests except one (Drive Tank During Main Gun Engagement). However, in the tactical category of tests it was determined that not only was scoring by the TC/gunner necessary, it was also desirable. In these tasks, instead of trying to avoid subjective TC evaluation (e.g., smooth stop, steady acceleration), it was decided to concentrate on some aspects of subjective evaluation, correlating such evaluations with the objective, quantitative measures simultaneously obtained, resulting in a better definition of the subjective terms for future use.

In addition to the scoring instruments (scoresheets), instructions for setting up and administering the test were also prepared.

Developmental Tryouts

A one-day pilot performance of all the prepared tests was conducted at Fort Knox at the area known as Pickett Driving Range and in the adjacent area to the south of the driving oval generally used for vehicle recovery training. This area was also to be used for actual testing; however, it was not entirely suitable for the tests to be conducted. Space was limited and terrain was marginally adequate for most of the tactical tests and inadequate for others; therefore, three tests had to be dropped. However, it contained some needed hardstand and it was immediately adjacent to the driving range from which test subjects would be obtained--a prime consideration for the choice of location.

The 1st AIT OSUT Brigade, Armor, provided the equipment (one M1 tank) and personnel for the tryout. Personnel consisted of seven NCO (E-5 and E-6) who were M1 OSUT trainers. Thus they served as subject matter experts for technical review of the material as well as specialists in OSUT training, in addition to serving as performers, TC and scorers. There were no subjects _per se_ tested.

The main conclusions from the developmental pilot test were:

- The M1 is operationally much more technically sophisticated in movement than anticipated. Firing on the move, for example, requires much less driver attention to bumps, terrain interruptions, and turns than did the M60 series. Except for shifting, there is very little skill required from the driver in maintaining a steady platform when operating at moderate speeds in even moderately rough terrain.

- OSUT trainees (the target test audience) are virtually totally unfamiliar with any tactical employment of the vehicle. Terminology such as hull defilade and missile evasion would mean nothing to them and they would have to be trained in what is expected of them prior to any testing. The same is true of controlling the tank during main gun engagement.

- When actually tested, OSUT trainees would have had approximately 15 minutes of driving experience. Mistakes would be numerous; some mistakes could be potentially dangerous. OSUT trainees would probably rely heavily on instructions from the TC; they would not perform many steps without the TC "OK," even after being instructed on what to do. This could be a problem in testing in that it introduces the aspect of cued behavior with some examinees. Test instruments are not designed to accommodate this.

- Width judgment has more facets than originally anticipated and includes such considerations as deciding whether clearance is possible and navigating the obstacles once the decision is made. Because of the frequent requirements for skills relating to width maneuver, this area was judged highly important. Height judgment on the other hand appears to have limited application, is "easy" to judge, and requires no skill once judgment is made. Of all the tests piloted, height judgment was thought by SME to have the least application.

- All piloted tests were determined to be feasible. Major modifications were suggested in the main gun engagement test and on width judgment, but most of the remaining tests required only minor modifications and clarifications.

Test Revision

Based on the developmental tryouts, two tests were added and other suggested modifications were made to the other tests. Equipment requirements and scoring instructions were also finalized. The revised tests are contained in Appendix A. A brief synopsis of each test is contained below. The distinction between Tactical tests and Obstacle/Judgment tests was retained as a convenient administrative classification. In actuality the distinction has no implication for level or difficulty of skills nor for applicability to whole task performance. The Tactical tests, for example, involve measures of discernable individual skills and should not be construed as directly predicting actual full tactical performance. Neither category of task should be judged as more important or meaningful than the other.

Synopses of Obstacle/Judgment Tests

- Follow Ground Guide Signals. Designed to measure the driver's skill in responding to ground guide signals in a tight maneuver situation. Because a ground guide is used, the control of the tank is essentially the ground guide's responsibility. Any barrier strikes were assumed to be the result of the failure of the driver to respond correctly to the ground guide signals. Time measures reflected the need for adjustments in movement. All tank movement was while driving in reverse, with steering opposite that of forward movement.

- Right and Left Turns. Designed to measure the driver's skill in maneuvering in a constricted area without assistance. The driver's instructions were to stay as close as possible to an engineer tape barrier without striking it. Two 90 degree turns, one left and one right, were included. The barrier existed on only one side of the tank; the other side was open.

- Align Tank for Width. Designed to measure the driver's ability to control and adjust the position of the tank within narrow confines without assistance. Drivers negotiated a straight passage with engineer tape barriers on each side. The passage entrance was 205 inches and each side narrowed to a 157 inch exit. The

barrier was set at fender height. The drivers made a 90 degree or greater turn into the passage about 10 meters from the passage entrance.

- Width Judgment. This test consisted of three sets of movable gates, one set of which was too narrow for the tank to pass through (144 inches). The other gates were set at 157 inches and 169 inches. If the driver judged that he could clear the set of gates, he was to drive through the gates; if he judged he did not have clearance, he was to bypass. The location of the narrow gate was changed after each examinee. Skills measured included accuracy of each width judgment, steering and positioning of the tank, control of the tank and a time measure reflecting both the decision and control.

- Height Judgment. Designed to measure the driver's perception of overhead clearance and his judgment of close tolerances, and to identify points of confusion in height judgment. This test consisted of six gates with overhead barriers set at heights of 114, 115, 116, 117, 118, and 119 inches clearance. All but the 114 inch barrier are passable by an M1 tank with the TC hatch in the protected position. Drivers were to pass under those gates they judged passable and to bypass any gate they judged unpassable. The location of the 114 inch gate was to be moved for each examinee. All judgments were made without assistance.

Synopses of Tactical Tests

- Control Tank During Main Gun Engagement. Designed to measure the driver's skill at minimizing anything that interferes with the gunner while engaging targets on the move. It was also to identify driver behavior in orienting the front of the tank toward the target and in reacting to impassable obstacles in the path of the tank during the engagement. Primary measures were to be the gunner's evaluation of the percent of time he was able to maintain lay on the target and a count of the number of transmission shifts during the engagement. Time to traverse the standardized engagement distance reflected the driver's ability to maintain a constant speed. Subjective TC evaluations were gathered for experimental use.

- Acceleration and Stopping. The driver, on command and from a stop, accelerated as fast as possible and stopped as close as he could to a marked line within right and left boundaries. Measures included the driver's skills in judging tank stopping distance and his ability to control the tank in rapid acceleration/rapid deceleration conditions.

- React to TC Command - Missile, Duck. Upon command, the driver was expected to move to a position of total defilade. Skills measured were the driver's reaction time, vehicle control, vehicle position and the driver's judgment of the vehicle size and shape relative to other objects (the defilade). To some extent the test measured the driver's understanding of the missile evasion concept. Subjective TC evaluations were gathered for experimental use.

- React to TC Command - Hull Defilade: Upon command, the driver was to move to a position of hull defilade with the gun capable of engaging the target (free of obstructions). Skills measured were the driver's reaction time, vehicle control, vehicle position control, vehicle position and the ability tc obtain hull defilade. To some extent the test was to measure the driver's understanding of the hull defilade concept. Subjective TC evaluations were gathered for experimental use.

Testing

Testing Schedule. Testing was conducted in two phases. During May 1982, all the Obstacle/Judgment tests except one were tested over a two-day period. Height Judgment was not tested at this time because of equipment problems. All Tactical tests plus the Height Judgment tests were administered on one day in September 1982. All testing was conducted at Fort Knox, Kentucky. The May testing was conducted at the Pickett Driving Range area which was also used for the developmental tryouts. The September testing was conducted at Training Area 13, which afforded more room and more variation in terrain.

Test Subjects. In May, 44 M1 OSUT trainees were tested; in September 33 different M1 OSUT trainees were tested. Both groups' previous hands-on driver training consisted of approximately 15 minutes of driving on the TSC course.

OSUT personnel were tested because of their availability and the uniformity of their pretest experience. However, the tests were not designed as a measure of OSUT skills. None of the tests had been specifically trained in OSUT with the possible exception of Ground Guide Signals. Some of the tactical skills were covered in instruction but not practiced. Therefore, soldiers were told the requirements of the Missile, Duck and

Hull Defilade exercises at least twice immediately before testing. The inconsistency of the test content with the experience and performance level of the examinees could have influenced the testing outcome since more performance cues were required to compensate for their lack of experience.

Scorers. Eleven military and seven civilian scorers administered the tests. Each tank had a military TC and a military person as a ground guide. All military personnel were NCO in the rank of E-5, E-6, or E-7, assigned to the 1st AIT/OSUT Brigade, Armor. Civilian scorers were HumRRO personnel. When feasible two scorers obtained the same measure and, where resources permitted, a military and civilian scorer were paired to obtain the measure.

Scorers received a briefing on their requirements and, where possible, a walk-through of the tests. However, because of equipment and personnel availability the scorers lacked the full training regimen of a field test for test validation. This requirement should be emphasized in any test replication.

Test Organization. The first phase of testing (Obstacle/Judgment) was organized into two stations. The first station tested Ground Guide Signals and Left/Right Turn. Both tests were conducted on the same physical set-up. The second station tested the Align for Width and Width Judgment tests but at two separated sites. No attempt was made to control the sequence of the stations; soldiers were assigned to the station and their sequence was not recorded. Within Station One, soldiers followed a set pattern with half being tested on Ground Guide first and half on Left/Right Turn first. At Station Two, soldiers were always tested first on Align for Width. Soldiers switched tanks between Station One and Station Two. All the tests in Phase One were conducted with the driver's hatch open.

None of the soldiers tested in Phase One was tested in Phase Two (Tactical tests). Phase Two consisted of a circular course approximately 1.5 miles long. Each soldier remained on the same tank for all Tactical tests, and all were tested in the following sequence:

- Main Gun Engagement
- Missile, Duck
- Hull Defilade
- Acceleration and Stopping

All Tactical tests were conducted with the driver's hatch closed; in fact, drivers kept the hatch closed during the entire testing circuit.

The Obstacle/Judgment test, Height Judgment, was conducted in conjunction with the Tactical tests. Twenty-five of the 32 soldiers tested on the Tactical tests were tested on Height Judgment. The majority of these 25 were tested before taking the Tactical tests but no record of sequence was kept. Height Judgment was conducted with the driver's hatch open.

Test Modifications. Tests were conducted as outlined in the individual test instructions, Appendix A, except as discussed below.

- Follow Ground Guide Signals. To determine if having a driver make a left turn or right turn while being ground guided in reverse made a difference in performance, the conduct of the test was modified to have one-half of the soldiers make right turns and the remaining left turns.

- Left-Right Turn. The test was written to require soldiers to make both a right turn and a left turn. During administration, a slight modification was introduced that had one-half the soldiers making the right turn first and half the left turn first.

- Control Tank During Main Gun Engagement. The test was designed to measure the percentage of time that the gunner was able to maintain lay on the target during the engagement. Unfortunately, due to shortage of personnel, no gunners were available and no data on this measure were gathered.

  As the test of Control Tank During Main Gun Engagement was orginally set up, the driver was to be measured on his ability to maintain 20 mph, his ability to keep the front of the tank oriented in the directin of the target, and his announcing of avoiding an obstacle. Very early in the testing, problems were encountered with all three measures. The terrain was bumpy and at 20 mph, while no problems were encountered in the driver's compartment, the terrain was too rough for the TC/scorer to manipulate stopwatch, scoresheets, and other scoring and control materials. Therefore, the speed requirement was

deleted from the instructions (from this test and the Missile, Duck and Hull Defilade tests which followed) and the driver selected his own speed.

In the instructions the driver was told that he was to keep the front of the tank oriented on the target. The plan was to have the driver start the run at an approximate angle of 30 degrees off the target and then have the gun laid on the target during the run. Because of the terrain, however, only an angle of 5 degrees through 10 degrees could be obtained.

The terrain during the test also did not allow for an unavoidable obstacle necessitating an announced turn from the required path and no data were gathered on these measures. (Additionally, the requirement to announce turns is not doctrinally clear for the M1; it is probably a matter of severity of the turn, and is dependent on crew requirements and training.)

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RESULTS

There are four major aspects of the results of the M1 tank driving tests. The first concerns measurement reliability. In most cases measures of scorer agreement were obtained, with 80 percent agreement being the desired minimum standard of scorer agreement.[1] For some tests, agreement among several methods of obtaining evidence of the same skill is presented. The second aspect concerns utility of measures, based on their reliability and variability. The third aspect involves test revisions and recommendations for future testing based on the data and on informal observations. These three aspects are presented on the following pages for each of the nine tests. The fourth set of analyses of the results concerns the intercorrelations among the tests. These analyses follow the presentations of results for the individual tests.

Results for the Tests

Follow Ground Guide Signals. An experienced (E-5 tank commander) ground guide directed examinees driving in reverse through the course. Observation and debriefing did not identify any instances of ground guide-induced barrier strikes or delays.

The data collected during the Ground Guide test were the time and number of barrier strikes before the turn, during the turn, and after the turn. Two observers counted the strikes, by location. The number of strikes recorded for each soldier by each scorer was quite low for both right turns and left turns. No more than two strikes were recorded for any soldier in all but one case. It was also the only case where more than one strike was recorded for any location. One of the scorers noted three barrier strikes for one soldier, while the other scorer recorded only two strikes. Therefore, the number of strikes was rescored to indicate whether or not any strikes occurred at each location. Two strikes in one location were recoded as a single strike.

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[1]Agreement percent was computed as the number of soldiers for whom scorers gave the same scores divided by the total number of soldiers scored by both scorers. The 80% standard was desired but surrounding testing factors were considered when the agreement was near enough to make judgments about reliability.

Agreement between scorers was high for both right and left turns (Table 2). Full agreement--i.e., whether or not a strike occurred in each location-was 86.4 percent for both the right and the left turns. The high percentages were the result, at least in part, of the small number of strikes: scorers agreed that 15 (68.2 percent) soldiers on right turns and 13 (59.1 percent) soldiers on left turns had no strikes. For those soldiers where scorers agreed that at least one strike occurred--five soldiers on the right turn and seven on the left--full agreement on locations of strikes was 80 percent on right turns and 85.7 percent on left turns.

All points of measuring scorer agreement on the Ground Guide test met the 80% criterion. Information on strike location for those cases where scorers agreed--19 cases each for the left and right turn--were considered in recommending test revisions.

The data suggest that left turns are more difficult than right turns (Table 3), but this observation must be tempered with the possibility that any difference in difficulty between right and left is quickly erased after initial brief practice. The location of the barrier strikes indicates that this might be so; the greatest difference is observed in number of strikes before the turn, with no difference in the number of strikes recorded during and after the turn. With more experienced drivers this initial problem probably should not exist. The time required to perform the test did not differ for right and left turns ($t = .757$, $p > .20$), and was varied enough across soldiers (ranging from 55 to 193 seconds) to be useful in discriminating among proficiency levels (Table 4).

Because of the control problems in large scale administration of both right and left turn versions of the test, and the indications that the two are of comparable difficulty, testing of either turn is justified. Right and left testing with a more experienced group of drivers to see if the right and left similarities replicate is advisable. The low number of multiple strikes suggests the possibility of dropping the requirements that the scorer record the number and location of hits and instead record only

Table 2

Number of Soldiers With Scorer Agreements on Barrier Strikes Before, During and After the Turn and Overall For Follow Ground Guide Signals Test

Turns	For All Soldiers				For Soldiers With One or More Strikes			
	Before Turn	During Turn	After Turn	Overall	Before Turn	During Turn	After Turn	Overall
Right Turn								
Strikes	1	2	1	4	1	2	1	4
No Strikes	21	19	18	15	4	2	3	--
Agreement Percent[a]	100%	95.5%	86.4%	86.4%	100%	80.0%	80.0%	80.0%
Left Turn								
Strikes	5	1	2	6	5	1	2	6
No Strikes	16	19	19	13	1	5	5	--
Agreement Percent[b]	95.5%	90.9%	95.5%	86.4%	85.7%	85.7%	100%	85.7%

[a]N = 22. Soldiers with one or more strikes, N = 5.
[b]N = 22. Soldiers with one or more strikes, N = 7.

Table 3

Number of Barrier Strikes On

Follow Ground Guide Signals Test

Turns	Number of Soldiers[a]			
	Before Turn	During Turn	After Turn	Overall
Right				
Strikes	1	2	1	4
No Strikes	18	17	18	15
Left				
Strikes	5	1	2	6
No Strikes	14	18	17	13

[a]N=19 soldiers with scorer agreement.

Table 4

Time Statistics

On Follow Ground Guide Signals Test

Turns	Time (Seconds)[a]	
Right	Mean	102.0
	S. D.	30.8
	Range	55-153
Left	Mean	109.9
	S. D.	37.3
	Range	56-193

[a]N=22.

whether or not a strike occurred. However, this should only be done if the distances to be traversed are not substantially increased from the 60 feet used in this version of the test.

The test materials used a two by four inch board angled out from the ground to fender height to mark the pivot point and hold the engineer tape for the inside lane marker. This worked well except in those instances where the barrier strike occurred at the pivot point, resulting in repair or replacement of the board. These delays are interruptive and costly to a full test schedule; however, any other barrier arrangement must allow the tank side skirts to be within one to two inches of the barrier without interfering with the tracks.

Right and Left Turns. The total number of barrier strikes was recorded in each category (Before, During, and After Turn) for the two turns for each soldier. A record was kept if the driver struck the barrier two, three, or more times, and the locations where the strikes occurred. Scorer agreement, on number and location of strikes, was 88.6 percent for both the right and the left turn (see Table 5). As with the Ground Guide test, both scorers recorded no strikes for a majority of the soldiers: 31 (70.5 percent) on the left and 25 (56.8 percent) on the right. For those soldiers where scorers agreed that at least one strike occurred--11 soldiers on the left turn and 17 on the right--full agreement on location and number of strikes was 72.7 percent on the left and 82.4 percent on the right.

One soldier performing the left turn and one performing the right turn scored three strikes; in both cases the strikes occurred in the portion of the turn before the pivot. Scoring of strikes in each category (Before, During and After Turn) should be reduced to No Strikes, One Strike, and Two or More Strikes and future scorers should not be tasked with counting strikes over two, since so few soldiers had more than two strikes.

For the cases where scorers agreed on location and number (0, 1, 2 or more) of strikes--39 on the left and 40 on the right (Table 6)--the turn itself appears to be the most difficult portion of the test, in judgment, in controlling the tank, or both. The right turn also appears to be more

Table 5

Number of Soldiers With Scorer Agreements On Barrier Strikes Before, During and After the Turn and Overall for Right and Left Turns Test

	For All Soldiers				For Soldiers With One or More Strikes			
Turns	Before Turn	During Turn	After Turn	Overall	Before Turn	During Turn	After Turn	Overall
Left								
Three or More Strikes	1	0	0	1	1	0	0	1
Two Strikes	1	2	1	1	1	2	0	1
One Strike	3	6	0	7	3	6	1	7
No Strikes	36	34	42	31	6	1	9	--
Agreement Percent[a]	93.2%	95.5%	97.7%	90.9%	100%	81.8%	90.9%	81.8%
Full Agreement				88.6%				72.7%
Right								
Three or More Strikes	0	0	0	1	0	0	0	1
Two Strikes	1	0	0	2	1	0	0	2
One Strike	3	10	4	11	3	10	4	11
No Strikes	36	32	40	25	12	6	13	--
Agreement Percent[b]	90.9%	95.5%	100%	88.6%	94.1%	94.1	100%	82.4%
Full Agreement				88.6%				82.4%

[a]N = 44. Soldiers with one or more strikes, N = 11.

[b]N = 44. Soldiers with one or more strikes, N = 17.

difficult--more soldiers had strikes during the right turn than during the left. At the same time, the left turn resulted in a somewhat wider turn radius (Table 7). The difference in radius is not statistically significant ($t = 1.37$, $p > .10$) but it appears that drivers had some difficulty in judging their position for the turns, and the difficulty was different for left and right: more strikes on the right, wider turn on the left. The reason for the difference in performing the turn between right and left is not immediately obvious. (The M1 driver's hatch is on the driver's right when open.)

The times for the two turns are not different, but for both turns the longer times were associated with shorter turn radii, while short times occurred for both long and short turn radii. It is not know whether this will replicate with more experienced drivers, however, it is recommended that both right and left turns be retained in future testing.

All these measures--location of strikes, length of turn radius, and time--have sufficient variance, in addition to their usefulness as measures of driving performance, to be included in future testing.

The same problems with the pivot point durability described in the Ground Signals Test applied here as well.

Align Tank for Width. Several measurements of width alignment were explored during the testing. The measures included whether each barrier strike was brief or sustained, where on the tank the strike occurred (front, side, or rear), and in which quarter of the passage the strike occurred. The scorer agreement in each of these areas is shown in Table 8.

Scorer agreement on whether or not a hit occurred and the number of hits occurring was rather good--97.7 percent on the left and 86.4 percent on the right. Multiple strikes (two or more) were recorded only two times by the scorers, however, and on only one of these were both scorers in agreement that a multiple hit took place. No more than two strikes were recorded

Table 6

Number of Barrier Strikes On Right and Left Turns Test

Turns	Number of Soldiers[a] Before Turn	During Turn	After Turn	Overall
Left				
Two or More Strikes	0	0	0	4
One Strike	3	5	0	7
No Strikes	36	34	39	31
Right				
Two or More Strikes	2	0	0	4
One Strike	3	9	4	11
No Strikes	35	31	36	25

[a]N=39 for left turn; N=40 for right turn; soldiers with scorer agreement.

Table 7

Turn Radius and Time Statistics on Right and Left Turns Test

	Turn Radius[a]	Time (Seconds)[a]
Mean	19'6"	57.1
S.D.	5'10"	22.3
Range	12'2"-31'6"	24-106
Mean	17'9"	61.7
S.D.	5'6"	24.0
Range	10'6"-33'6"	29-133

[a]N=39 for left turn; N=40 for right turn; soldiers with scorer agreement.

Table 8

Number of Soldiers with Scorer Agreements on Number of Strikes, Duration of Strikes, Portion of Tank, and Quarter of Passage for Align Tank for Width Test

Measures	For All Soldiers Left	For All Soldiers Right	For Soldiers With One Or More Strikes Left	For Soldiers With One Or More Strikes Right
Number of Strikes				
Two Strikes	0	0	0	0
One Strike	7	6	7	6
No Strikes	36	32	--	--
Agreement Percent	97.7%	86.4%	100%	75%
N	44	44	7	8
Duration of Strikes				
Sustained	3	6	3	6
Brief	1	0	1	0
No Strikes	36	32	--	--
Agreement Percent	95.24%	86.36%	66.7%	75%
N	43	44	6	8
Portion of Tank				
Front	5	1	5	1
Rear	0	0	0	0
Side	0	3	C	3
No Strikes	36	32	--	--
Agreement Percent	93.2%	81.8%	71.4%	50%
N	44	44	7	8
Quarter of Passage				
Strike/ First	0/43	3/39	0/7	3/7
No Strike Second	1/40	2/39	1/4	2/7
Third	3/39	2/39	3/3	2/7
Fourth	5/37	4/35	5/1	4/3
No Strike	36	32	--	--
Agreement Percent	93.0%	86.0%	66.7%	65.5%
N	43	43	6	8

in a multiple strike. When agreement percentages included soldiers with no strikes, the results were very high. Agreements were much lower, however, for only those soldiers on whom a strike was scored.

The low scorer agreement in some of these areas may result from the method. The passage was relatively short (approximately 60 feet) and difficult to divide into quarters, and the quarter distinction was difficult to ascertain in sustained strikes. The distinction between a front of tank strike and a side tank strike was difficult. Many strikes occurred at the exit end of the barrier where it was difficult to determine whether the strike was brief or sustained and to determine exactly where on the tank the strike occurred. A number of times a driver struck a barrier support or the engineer tape became entangled in the tracks so it was virtually impossible to score accurately the type and number of hits. For these reasons it is recommended that the strike descriptive measures and number of strikes be dropped from subsequent applications of the test, and scoring concentrate on whether or not a strike occurred. This deletion should also simplify the scoring process.

The time required for the test ranged from 22 to 130 seconds, which does not appear to be an immediately useful evaluation measure. Operationally, navigation of a narrow passage dictates some caution on the part of the driver and speed should not be emphasized. At some point the time expended becomes excessive, but a 60-second variation has little operational impact. Time is reported here to assist in the planning of future tests; because of difficulty in interpreting the time factor it is recommended that it be dropped.

The drivers were required to make a turn into the barrier passage to avoid having the tank already lined up or almost lined up with the passage. Based on observations, very few drivers had problems lining up the tank after the turn for entry into the passage. If test conditions in subsequent application preclude the turn it would probably make little difference in the outcome of the test, particularly if more experienced drivers were tested, although intuitively the retention of the turn is attractive.

One problem was encountered with stability of the engineer tape barrier. The tape was braced at the midpoint with an upright, but even a mild wind blew the tape in on one side and out on the opposite side. Scorers compensated by using the upright stakes as a line of sight reference and ignoring the actual position of the tape. However, it is unknown how much this movement of the barrier affected drivers. One way of compensating for this is to erect more uprights, but rebuilding slows test administration when uprights are knocked down.

Width Judgment. Only one scorer gathered data for the width judgment test. An incorrect decision was scored if a driver tried to drive through the 144 inch gate or bypassed the 157 inch or 169 inch gates. As shown in Table 9, there were as many soldiers with incorrect decisions on the 169 inch gate as on the 157 inch gate, but the judgment about the 144 inch gate was significantly worse.

Table 9

Number of Soldiers With Correct Decisions By Gate and By Number of Correct Decisions For Width Judgment Test

Gate Width	Correct Decision	Number Correct (N=43)
169 inches	Attempt	35 (81.4%)
157 inches	Attempt	36 (83.7%)
144 inches	Bypass	31 (72.1%)

Correct Decisions After All Gates

Number of Correct Decisions	Number of Soldiers (N=43)
Three	22 (51.2%)
Two	15 (35.9%)
One	6 (14.0%)

The soldier was also scored on whether or not he cleared the gate, if he attempted it (see Table 10). Although the total number of times that the driver did not clear passable gates was small (11), seven of these occurred on the 169 inch gate and only four on the 157 inch gate. Drivers may have tried to navigate the wider gate faster or with less care. Out of the 70 possible opportunities for strikes, when soldiers attempted the passable gates, strikes occurred in only 15.7 percent of the cases (11 strikes). This number of strikes is low and could be expected to decrease with more experienced drivers.

Table 10

Number of Soldiers With Gate Strikes By Gate and By Number Of Gates Struck for Width Judgment Test

Gate Width	Number of Attempts	Number of Strikes
169 inches	35	7 (20.0%)
157 inches	35	4 (11.4%)

Number of Strikes Over All Gates

Number of Gates Struck	Number of Soldiers (N=31)
Two	0
One	9 (29.0%)
None	22 (71.0%)

Because so few gate strikes were recorded, the usefulness of this variable is questionable, although gathering information on gates struck is not costly and did not appear to interfere with other scoring requirements. The variable should be retained, at least until further testing provides more information for a firmer decision.

The time required to perform the Width Judgment test ranged from 6 seconds to 102 seconds. Because this is largely a function of the soldier's decisions to bypass gates or attempt to pass through, and because time to perform is not a critical element, this measure should be deleted.

Height Judgment. For this test, two scorers--a ground observer and the tank commander--scored whether the soldiers bypassed or attempted to pass through each of the six gates. For five of the gates, the correct decision was to pass through, and for one gate the correct decision was to bypass. Only 25 soldiers were tested on height judgment, and complete data were obtained for 18 of the 25 soldiers. Seven soldiers had incomplete data because of conflicting demands for the TC/scorer's attention.

Scorers agreed on the number of correct decisions for 16 soldiers (Table 11), representing 88.9 percent of soldiers with complete data. However, scorers were reliable on only 64 percent (16 of 25) of the scores; the 8 occasions involving 7 soldiers where data were not recorded represent unreliability among the scorers. For one of those sixteen agreements on the number of correct decisions, scorers did not agree on the gates where correct decisions were made. Thus scorer reliability is reduced to 60 percent.

Table 11

Number of Soldiers With Scorer Agreements By Gate and By Number of Correct Decisions For Height Judgment Test

Number Of Correct Decisions	Number Of Agreements[a]	Gate Height	Agreements[b] Correct Decision	Incorrect Decision	Percent Agreement
Six	4	119 inches	21	3	96.0%
Five	4	118 inches	19	6	100%
Four	4	117 inches	18	5	92.0%
Three	3	116 inches	13	5	100%
Two	1	115 inches	14	9	95.8%
		114 inches	15	12	100%
Agreement Percent	88.9%	Full Agreement[a]			83.3%

[a]N=18.

[b]N=25. For 116 inch Gate, N=18. For 115 inch Gate, N=24.

Scorer unreliability stemmed, at least in part, from the use of the tank commander as a scorer. The TC was required to operate with the hatch in the protected open position, which decreased visibility and hampered the manipulation of scoresheets, stopwatch and pencil. The TC was also required to divide his time between scoring and control of the driver, with driver control his paramount responsibility.

During the testing only one gate was impassable (114 inches). This gate was switched with one other after approximately every fourth examinee. However, the switching was not random--the impassable gate was always either Gate 1 or Gate 4.

Considering only those cases, on each gate, where scorers agreed on the soldier's decision, the relative difficulty of the decisions for the six gates is shown in Table 12. The number of correct decisions forms a consistent ascending pattern. But of the 15 soldiers on whom scorers agreed on the decision for every gate, 8 soldiers (53.3 percent) displayed a pattern of decisions in which they never decided to pass through a gate which was smaller than a gate they bypassed. So, while the collective discriminations appear to be consistent, the actual individual patterns are not.

Table 12

Number of Correct Decisions By Gate For Height Judgment Test

Gate Height	Number of Soldiers[a]	Number Correct	Percent
119 inches	24	21	87.5%
118 inches	25	19	76.0%
117 inches	23	18	78.3%
116 inches	18	13	72.2%
115 inches	23	14	60.9%
114 inches	25	13	52.0%

[a]Soldiers with scorer agreements.

Scorers were not in full agreement on the times recorded. For the ground observer, times ranged from 46 to 159 seconds; for the tank commander, the times were from 71 to 230 seconds. The correlation between the two is significant ($r = .673$, $p < .001$), but the variance is too high to be acceptable. Again, the TC workload affected time correlations. Scorer training emphasis on how to handle the timing of out-of-the-ordinary driver performance, such as when the soldier hesitates after the final gate before reaching the stop point or when drivers have false starts, might improve the agreements.

This test drew the most negative reaction from military scorers and observers from the OSUT battalion cadre of all the tests tried out. Their main negative reaction was that the judgment required in the test was unrealistic--that on the job no similar driver reaction is expected or even desired. (It is worth noting that similar objections were not raised with other tests in which the tested driver requirements do not match job conditions. In many of the tests involving judgments the requirement on the job does not call for the driver to make decisions unassisted. Why this test has been singled out for comment is not clear; perhaps it is a matter of the degree of driver involvement. Height judgment is primarily a TC responsibility; the other tests are at least partially a driver's responsibility. This, however, is only conjecture, as during the M1 Driver Survey from which the tasks were selected no objections to this as a driver activity were noted.)

This test is the most difficult to set up of all tests used. Approximately 12 man hours were required for setup, which did not include time required for filling sandbags to secure the upright posts. The test is also difficult to administer in that personnel and time are required to change the height of the barriers and to replace knocked-down barriers.

Two problems which could occur with future tests surfaced during the tryouts. The first of these concerns the impassable gate. Because the tolerance is very close (114 inches) a very slight disturbance in ground contour allows the tank to pass under the 114 inch barrier, which occurred for at least three of the examinees. Likewise on the close, passable

barriers (115 inches and 116 inches) a slight buildup of dirt causes a barrier strike. Every effort was made to minimize this by "tracking" the course repeatedly before the test but the course height still changed with each run of the circuit--and, of course, the change was uneven, so remeasuring before each run, besides being impractical, does not solve the problem. The only solution would be to run on a dry, hard surface (or paved or concrete) course.

The second problem did not occur during testing but was observed during the aforementioned tracking runs of the course using an experienced driver. When the M1 is driven fast and the terrain is rough, the tank can bounce up and strikes otherwise passable overhead barriers. Thus measurement for this test should not only include the judgment factor but also may have to consider the skill factor in actually negotiating under the obstacle.

As originally conceived, this test would be combined with the width judgment test. The driver would be presented with a series of rectangles in which the height and width would vary but the total "open" footage would remain relatively constant. This method was not practical because of the difficulty in constructing and stabilizing upright posts ten feet tall without using interior space. If this combination testing is to be used a more sophisticated approach to barrier construction will have to be devised.

This test should be reanalyzed before it is tested again. One of the considerations should be whether, as presently outlined, the distinctions between barrier heights are too fine. Only five inches total separated the impassable barrier from the highest barrier. It may be that drivers should be required to make grosser distinctions; e.g., those heights that can definitely be cleared, those heights that definitely cannot be cleared, and those heights when the driver must have TC assistance for a decision. Translating these classes into specific measures is, of course, a distinct problem. However, as presently constructed it is difficult to say that a driver who bypasses the 115 inch barrier, for instance, is "wrong," whereas on the job he might be encouraged to take this cautious approach. In the final analysis the test must remain consistent with field procedure if it is to be used on a wider scale.

Control Tank During Main Gun Engagement. Two measures of "steady platform" were employed in the test. One was the percentage of time in which the gunner was able to maintain a lay directly on the target, and the other was the number of times the transmission shifted during the engagement. Unfortunately, no data on the first measure were gathered because a shortage of test personnel precluded having any gunners.

The other measure (transmission shifts) was also disappointing in that, because of scorer misunderstanding, data were gathered from only eight soldiers. However, even these sparse data, as shown in Table 13, hold some promise, by virtue of the variability, that this measure may potentially provide a good quantitative measure. Both have sufficient potential to be retained in future testing.

Table 13

Number of Soldiers By Number of Transmission Shifts On Control Tank During Main Gun Engagement Test

Number of Transmission Shifts[a]	Number of Soldiers	Percent (N=8)
One	1	12.5%
Two	5	62.5%
Four	2	25.0%

[a]Average=2.5 shifts.

Engagment times ranged from 12-65 seconds with an average of 35 seconds. At 20 miles per hour, as originally planned, the engagement probably requires 15 to 20 seconds.

As the test was originally set up, the driver was also to be scored on his ability to keep the front of the tank oriented in the direction of the target and his announcing of the avoidance of an obstacle. As discussed earlier, conditions were such that tank orientation was not difficult to

maintain, and reaction to an obstacle could not be tested. No variation among drivers in orienting the tank was recorded; all drivers were scored as having oriented the front of the tank towards the enemy.

In summation of these three measures--ability to maintain 20 miles per hour, tank orientation, and reaction to obstacle--it is recommended that the 20 miles per hour speed be maintained as a requirement in future test applications with the understanding that terrain may force modifications. The requirement to turn the tank so that the front is facing the enemy should also be retained but only if the terrain permits measurement. The obstacle requirement should be dropped. It is difficult to set up and, if run at 20 miles per hour, requires too many diverse measures in a very short time and represents a new and unevaluated threat to scorer reliability.

Acceleration and Stopping. The measurements taken consisted of time from start to stop and distance over or short of the stop line. The average time to cover the 60-meter distance was 24 seconds and times ranged from 8 seconds to 48 seconds. A measurement was made from the stop line to where the tank actually stopped. (During testing, drivers were not allowed to stop and then move forward to the line--they were stopped where movement of the tank first halted.) It is of some significance that none of the 32 drivers exceeded the stop line boundary. The average distance short of the line was 9 feet and 3 inches with the range from 0 to 40 feet. Two drivers stopped exactly on the line.

The stop line was also marked off with right and left boundaries at a width of 20 feet, but measurement indicated that no one exceeded the right or left limits. If even novice drivers have no problems maintaining the tank within these limits it is recommended that for future tests the limits be decreased to closer to the 12-foot tank width (perhaps 15 feet) or that this measure be dropped, with the latter choice being favored.

TC/scorers also made subjective ratings of both the movement (acceleration) and the stopping (Table 14). Because neither of these subjective evaluations relates directly to speed, no correlation was computed with actual times to traverse the course. Although there might be some

diagnostic value in the stopping evaluation, there does not appear to be enough variation in the acceleration evaluation to warrant its retention (the situation is unlikely to improve among experienced drivers) and it should be deleted. If the stopping evaluation is retained, it should be condensed into three categories (Smooth, Jerky, Abrupt).

Table 14

Number of Soldiers By Acceleration Rating and Stopping Rating on Acceleration and Stopping Test

Rating	Number of Soldiers	Percent[a]
Acceleration		
Smooth	28	90.3%
Jerky (Acceptable)	3	9.7%
Jerky (Unacceptable)	0	0.0%
Stopping		
Smooth	11	35.5%
Jerky	13	41.9%
Too Slow	2	6.5%
Abrupt	5	16.1%

[a]N=31

<u>React to TC Command (Missile, Duck).</u> OSUT drivers were expected to have problems with the concept and execution of this maneuver; therefore, they were briefed before the run on exactly what the manuever required. While many did have problems, particularly in reacting, performance varied from poor to good. TC gave subjective ratings on the timing of the move and the speed of the move, once the driver reacted (Table 15).

Table 15

Numbers of Soldiers By Ratings of Speed and Timing on Missile, Duck Test

	Timing Rated		
Speed Rating	Immediate	Delayed	Total
Fast Enough	10	9	19
Too Slow	1	9	10
Total	11	18	29

The majority of OSUT drivers hesitated in their reaction to the command (at least in the TC evaluation). Of those whose reaction was delayed, half then moved at a fast enough speed. Of the 11 soldiers who reacted immediately, all but one were then judged to move fast enough.

The lack of immediate reaction is also apparent in the times recorded. OSUT drivers required an average of 33.6 seconds to get into position, with a range of 12 to 61 seconds. In tryouts of the test, experienced drivers (the TC/scorers) took between 10 and 15 seconds from the point where the command was given to the defilade position; however, the slowness of the OSUT drivers in reacting was not unexpected. During testing TC were also asked to note in the scoresheet "Remarks" section any deviation from the expected performance. TC noted that 8 drivers (24 percent) either did not stop or could not determine the position and that another 9 drivers (27 percent) took up an improper position. In at least three situations they took a position on the left side of the course instead of the right side from which the simulated missile launch occurred. Although the drivers were told at least twice from which side the missile would be coming, some either did not understand this or did not comprehend the significance of the launch location.

The subjective TC ratings were examined to compare subjective evaluations of time-related events with actual times to see if a more objective evaluation of seemingly subjective criteria could be identified. As shown in Table 16, for the 27 soldiers for whom ratings and times were recorded, both subjective evaluations are strongly associated with actual times. Even

though highly correlated, the TC evaluations are probably of little quantitative value currently, and more in-depth study of the correlation between the subjective ratings and objective measures is needed before a use can be determined. However, they should be retained for future test applications, since they provide good diagnostic information and help focus training emphasis in some test applications.

Table 16

Actual Test Times of Soldiers By Levels Of Speed and Timing Ratings On Missile, Duck Test

Rating	N	Time (Seconds) Mean	St. Dev.	Difference
Speed				
Fast Enough	17	27.6	14.3	18.2 seconds
Too Slow	10	45.8	15.1	t = 3.13, $p < .01$
Timing				
Immediate	11	26.1	13.6	13.9 seconds
Delayed	16	40.0	17.0	t = 226, $p < .05$

Two scorers were used on the ground at a distance of approximately 100 meters from the hide position. They recorded three measures of exposure: a descriptive evaulation (maintained concealment, intermittent exposure, exposed throughout), a count of tank markings that were visible, and a mark on a drawing of the tank to indicate the portion exposed (see scoresheet in Appendix A).

On the first measure (Table 17), overall the scorer agreement was 77.4 percent. Two of the disagreements were between the first two responses (maintained concealment and intermittent exposure), three were between intermittent and exposed throughout, and two were full disagreements, between maintained concealment and exposed throughout. There may have been some confusion on the intent of this measurement. Some drivers were expected to pull into position initially, evaluate the position and then make position

adjustments based on that evaluation. This action seldom occurred and the ground scorers may have had problems determining exactly when the driver was in position. The descriptive evaluation did not discriminate correct from incorrect performance, although it is a fairly reliable description of what the driver did. Except for Exposed Throughout, the actions described are neither right nor wrong. Unless future tests with more experienced drivers reveal that position adjustment occurs with some frequency, this measure should be dropped.

Table 17

Number of Soldiers With Scorer Agreements on Evaluation of Amount of Tank Exposure on Missile, Duck Test

Evaluation	Number of Agreements
Maintained Concealment	7
Intermittent Exposure	6
Exposed Throughout	11
Agreement Percent[a]	77.4%

[a]N=31.

The second and third ground scorer measures were measures of the same thing using different methods of recording. For one of these measures, test tanks were marked across the front slope, side skirts and turret glacis with 1/2 inch yellow adhesive tape spaced 6 inches apart. There were three tape segments on the hull side skirts, three on the turret, and two on the front slope. The tape segments extended approximately 5 feet back on the skirts and to the rear apex of the frontal glacis on the turret.

The intent was to give scorers a handy, simple reference for scoring what they could see of the tank by recording the number of tape lines they observed on the hull and on the turret. The most frequent agreements were that the tank was fully exposed (3 hull tapes, 3 turret tapes) or fully concealed (no tapes visible) (Table 18). Of the 31 soldiers with complete

Table 18

Number of Soldiers With Scorer Agreements on Patterns of Tapes Visible For Missile, Duck Test

Measures	Number of Agreements[a]
Tapes Visible, Hull and Turret	
No Hull Tapes, No Turret Tapes	5
No Hull Tapes, One Turret Tape	1
No Hull Tapes, Three Turret Tapes	4
Two Hull Tapes, Three Turret Tapes	1
Three Hull Tapes, Three Turret Tapes	10
Full Agreement Percent[a]	67.7%
Tapes Visible, Hull Only	
No Tapes	15
Two Tapes	1
Three Tapes	10
Hull Agreement Percent[a]	83.9%
Tapes Visible, Turret Only	
No Tapes	5
One Tape	1
Three Tapes	18
Turret Agreement Percent[a]	77.4%

[a]N=31.

scorers agreed that 5 (16 percent) had no tapes visible, and 10 (32 percent) had all tapes visible. The total number of agreements was 21 or 67.7 percent.

Scorer agreement was slightly better for counts of hull tapes than for the turret evaluation. For hull tapes, scorers agreed on 15 cases of no tapes visible and 10 of all three visible, with total agreement of 26 (83.9 percent). For turret tapes there were 5 agreements on no tapes and 18 on all tapes, and a total of 24 agreements (77.4 percent).

As a supplementary means of measuring exposure, scorers were provided a two-view diagram of an M1 tank (see Scoresheet, Appendix A) and told to mark with a line the portion of the tank they could see. Subsequently a grid was prepared (see Figure 1) which divided the tank into seven segments. (Only the right side profile of the tank was used; because of the position of the tank no entries were made on the left side profile). This overlay was applied to each of the scorer's markings. If the scorer's marking included any part of a segment the entire segment was considered exposed. An analysis of the exposure and concealment agreement by segment is shown in Table 19.

Table 19

Number Of Soldiers With Scorer Agreements on Tank Segments Exposed Using Profile Overlay Method For Missile, Duck Test

Segment	Number of Agreements: Exposed	Number of Agreements: Concealed	Agreement Percent[a]
1. Gun Tube	18	2	64.5%
2. Turret Gun Mount	21	9	96.8%
3. Front Slope	10	18	90.3%
4. Turret Side Glacis	24	4	90.3%
5. Side Hull, Front	10	19	93.5%
6. Bustle Area	25	5	96.8%
7. Side Hull, Rear	10	18	90.3%

[a]N=31.

The greatest disagreement was whether the gun tube (Segment 1) was exposed or not. The scorer's main concentration is probably on the bulk of the tank and the gun tube is often ignored, especially if the main body of the tank is concealed. Additionally, the gun tube is the smallest of all the separate segements evaluated. Agreement on the remaining segments was quite good.

The agreement by segment patterns is shown in Table 20. Scorers agreed on a pattern of all seven segments in only a little over half of the cases (16, or 52 percent). One agreement was that the tank was fully concealed, five indicated that the full turret only was exposed, and ten agreed that the full tank was exposed. In the next column the agreement was computed when the only area of disagreement was whether the gun tube was exposed or not. The final agreement index excluded, in addition to the gun tube only disagreements, those cases where the disagreement was on a single adjacent segment (because a close inspection of the ratings showed many cases where the line the scorer drew could judgmentally be called in or out of the segment).

Table 20

Number Of Soldiers With Scorer Agreements on Three Patterns of Tank Segments Exposed Using Profile Overlay on Missile, Duck Test

Segment Patterns	Number of Agreements[a]	Percent
All Segments	16	51.6%
Six Segments (without segment 1, gun tube)	23	74.2%
Six Segments (within one adjacent segment)	25	80.6%

[a]N=31.

The comparison in Table 20 is presented to suggest what increased scorer training might achieve in such areas as attention to the gun tube. Additionally, the division of the task into the seven segments was somewhat arbitrary. Fewer segments would undoubtedly give greater scorer agreement although with a decrease in detail.

A comparison of the two methods of measuring exposure does not provide any clear guidance for future application. In this task the profile overlay suggests one advantage in that it provides more detailed exposure definition. Table 21 shows a comparison of the two methods using three categories of exposure: totally concealed, hull concealed and turret exposed, and totally exposed. The tape method appears to allow more leeway, with over one-fourth of the soldiers concealed, and approximately half totally exposed. By contrast, the profile method classified well over half of the soldiers as fully exposed. However, of the 14 soldiers for whom there were scorer agreements on both the tape method and the profile method, the two methods were in full agreement in categorizing the soldiers as exposed, partially exposed, or concealed.

Table 21

Number of Soldiers in Three Categories of Tank Exposure Using Tape Method and Profile Overlay Method of Determining Tank Exposure on Missile, Duck Test

Outcome	Tape Method[a]	Profile Overlay[b]
Tank Totally Concealed	5 (26.3%)	1 (6.2%)
Hull Concealed/Turret Exposed	4 (21.1%)	5 (31.2%)
Tank Totally Exposed	10 (52.6%)	10 (62.5%)

[a]N=19 soldiers with scorer agreement.

[b]N=16 soldiers with scorer agreement.

Because of the greater detail possible, the profile method probably gives a truer picture of what occurred. The profile method seems to offer advantages in quantitative scoring and individual and group diagnoses. However, it is unknown how much more detailed scoring could be achieved if more tape strips were added to the tank. The effect on scorer reliability of

tapes to observe and count is also unclear. On the other hand, scoring is simpler with the tapes. If the profile method is used the segment overlay should not be applied until after the scoresheet is filled out, to avoid influencing where the scorer marks the exposure. If a choice had to be made based on available data and usability of results, the indication currently would be to favor the profile method.

This test is highly terrain-dependent. During testing the position for the defilade was just large enough to conceal the tank and allowed little tolerance in height or width for a slightly incorrect position. On the other hand a much larger terrain feature would not provide much discrimination. Perhaps because of the size of the defilade or perhaps because of the indecision on the part of many drivers, the ground observers had trouble determining exactly at what point the driver was "in position." This was compounded by the fact that the defilade position was parallel with the path the tank had been following and movement towards the defilade was not always obvious from the ground scorer's location. Radio contact with the TC would have been helpful.

Minor material problems were encountered with the adhesive marking tape. Parts of several segments were torn off and segments located low on the tank became obscured with mud. A replacement tape with a better adhesive backing (such as duct tape or standard Army green tape but with high visibility) is needed.

One initial concern did not materialize. It was anticipated that later drivers could simply follow the tracks of previous drivers into the correct defilade position. Perhaps because drivers were so diverse in their reactions, this did not occur. The problem could arise with more experienced drivers.

React To TC Command (Hull Defilade). In almost all aspects of test administration and execution, this test is like the test of the Missile, Duck command. The prime difference is in the desired outcome. In Missile, Duck the goal is to have the entire vehicle defiladed, while in Hull Defilade the turret must be exposed to engage the target.

During the test the general target area was identified for the driver, but no clearly discernible actual target was used; additionally, the gunner's seat was not occupied. TC and scorers were, however, instructed to rate whether there was mask clearance from the gun to the target. They rated 13 drivers (41 percent) as having obtained mask clearance, 9 (28 percent) as not having obtained mask clearance and 10 drivers (31 percent) having missing data on this measure because TC failed to make an entry. While it is recommended that this measure be retained in future testing, the addition of a gunner would add to more complete and more accurate scoring.

Another measure that was recorded by the TC was the number of adjustments the driver made from his initial stopping position to a final position. The results, as shown in Table 22, reveal that most drivers (18) made no adjustments in any direction. This measure was used because of the accepted technique of pulling into a facing hull defilade until the target is visible to the driver, then backing down to the point where the target disappears from sight.

Table 22

Number of Soldiers By Number of Tank Position Adjustments in Each Direction and Overall on Hull Defilade Test

Number of Adjustments	Direction of Adjustment				
	Forward	Back	Left	Right	Overall
None	22	22	19	21	18
One	1	2	5	2	4
Two	1	0	0	1	0
Four	0	0	0	0	1
Six	0	0	0	0	1

It is not surprising that this technique was not widely used by novice OSUT-level drivers who may either be unaware of it or insufficiently experienced in its execution. However, even with experienced drivers who might use subsequent position adjustments, the measure is of dubious value because

of the confusion that can result in its use. While some Forward-Back Movement is a "positive" result--indicating use of a desirable technique--at some point the number of adjustments takes on a negative value because it indicates poor position selection, poor movement, or poor vehicle control. Because of the potential confusion attendant on this measure it is recommended it be dropped from future applications.

Time was recorded from issuance of the Hull Defilade command until the driver obtained his final position. TC/scorers also evaluated whether the speed was Appropriate or Too Slow. The speed for 72 percent of the drivers was rated as Appropriate and for 28 percent of the drivers was rated as Too Slow (three drivers' speed ratings were missing). However, unlike the results obtained in a similar measure for Missile, Duck, the results here did not intercorrelate (Table 23), partially because of the small number of ratings in the Too Slow category. Before deciding to drop this rating, additional data are needed. However, if almost three-fourths of OSUT drivers are rated in the Appropriate category, a more even division is not expected with more experienced drivers.

Table 23

Actual Test Times of Soldiers by Levels of Speed Rating on Hull Defilade Test

		Time (Seconds)		
Speed Rating	N	Mean	St. Dev.	Difference
Appropriate	21	25.2	11.7	6.2 seconds,
Too Slow	5	31.4	17.6	t = .96, not sig.
Total[a]		26.6	13.0	

[a]N=29.

A subjective measure of stopping (Smooth, Jerky, Abrupt) was also scored by the TC/scorers. They rated the majority of soldiers (19, or 61 percent) as having a smooth stop; only 2 (6 percent) had abrupt stops. Because of the lack of a clear use for this measure it is recommended that it be dropped.

As with the Missile, Duck test, the ground observers made two separate measures of tank exposure, one using strips of tape applied to the tank and the other using the tank profile. Both methods are described in the Missile, Duck test. However, both methods were somewhat more complex in application and analysis for this test. Whereas the Missile, Duck view from the ground was always of only one side of the tank, the hull defilade presentation was a head-on view that included portions of both right and left sides as well as the front of the vehicle. For the Missile, Duck test total defilade was the goal, while Hull Defilade requirements for a "good" score demand that the hull be concealed while the turret is at least partially exposed to allow engagement. A further complexity of this test, as administered, is scoring of the position of the turret. The driver cannot be held accountable for the orientation of the turret which, to some extent, determines which portions of the turret are visible to a ground observer; this is a gunner responsibility. Without gunners there was no way to standardize this aspect. Future testing should require a gunner who is instructed to lay on the same point each time, assuming he had mask clearance.

Of the 27 soldiers for whom scores were complete, scorers were in full agreement on number of turret, hull front, and hull side tapes in 19 (70.4 percent) cases. As shown in Table 24, scorer agreement was best on scoring the turret but lower for the hull front and hull sides separately. When the hull front and side tapes are considered as a whole, agreement drops to 78 percent. Since more variations are possible with both front and sides of the hull, this is reasonable. On the hull, most agreements came when none of the tapes was exposed, and with the turret most agreements occurred when all of the tapes were exposed, a result consistent with the frequency of these occurrences. Most of the scorings fall in the all (3 tapes) or nothing (0 tapes) areas with very few interim ratings or partial exposures.

Table 25 shows scorer agreement using the profile marking method. Agreement is by profile segments, computed for the right side profile, the left side profile, and for both profiles combined. With one exception (segment 6) the left side profile agreement is adequate, while the right side profile is deficient in four segments: 1, 2, 4, and 6. The main area of scorer disagreement is in profile segment 6, which is the rear half of the

Table 24

Number Of Soliders With Scorer Agreements on Patterns of Tapes Visible on Hull Defilade Test

Measures	Number of Agreements
Tapes Visible, Hull Front, Hull Side, and Turret	
No Tapes Visible	1
No Hull Tapes, Three Turret Tapes	12
No Hull Front, One Hull Side, Three Turret Tapes	1
One Hull Front, No Hull Side, Three Turret Tapes	3
Two Hull Front, No Hull Side, Three Turret Tapes	2
Full Agreement Percent (N=27)	70.4%
Tapes Visible, Hull Front and Hull Side	
No Tapes Visible	15
No Front, One Side Tape	1
One Front, No Side Tapes	3
Two Front, No Side Tapes	2
Full Agreement Percent (N=27)	77.8%
Tapes Visible, Hull Front	
No Tapes Visible	17
One Tape Visible	5
Two Tapes Visible	2
Full Agreement Percent (N=30)	80.0%
Tapes Visible, Hull Side	
No Tapes Visible	23
One Tape Visible	1
Full Agreement Percent (N=28)	85.7%
Tape Visible, Turret	
No Tapes Visible	1
Three Tapes Visible	27
Full Agreement Percent (N=31)	90.3%

turret. While not entirely explainable this may well be an artifact of the profile overlay. The division between segment 4 and 6 is the apex of the turret glacis, with segment 6 including the bustle area. Many of the scorer markings were just over the line dividing segments 4 and 6.

Table 26 shows the scorer agreement on individual evaluations for left and right profiles. Full agreement on all 7 segments is very low and increases considerably but not sufficiently when the controversial segment 6 is excluded.

Another way of analyzing the results is shown in Table 27. Since the critical distinction for scorers is whether the turret was exposed and the hull concealed, agreements on just those factors were computed without regard to the extent of the exposure or concealment. Only a slight increase in agreement is noted; that agreement does not differ from the agreement for a similar computation using the tapes.

An even more lenient measure of agreement on the profile method is to count an agreement whenever both scorers recorded any portion of the turret and hull exposed, on the right or on the left (Table 27). Even this agreement is less than 80 percent. It should be noted, however, that with the tape method it appears that one tank was fully concealed, while the profile markings indicate that every tank was at least partially exposed.

The profiles were given to the scorers without training or without any detailed explanation on their use. The use of both the left and right profile was not a stated requirement, and while the scorers generally used both, the prime area of concentration appeared to be on the left profile, probably because in most cases more of the left side of the tank was presented to them. Some scorer training and more detailed protocols would increase scorer reliability significantly in this test, but the effort may not be warranted. The tape segments appear to provide adequate measures for this test, and increased scorer training and practice might also improve agreement there. The profile method could provide more points of quantitative measurement, but the interpretation of this measurement is somewhat

Table 26

Number Of Soldiers With Scorer Agreements on Three Patterns of Tank Segments Exposed Using Profile Overlay on Hull Defilade Test

Segment Patterns	Number of Agreements	Percent Agreement
Right Profile		
All Segments	10	32.2%
Six Segments (without segment 6, bustle area)	16	51.6%
Left Profile		
All Segments	10	32.2%
Six Segments (without segment 6, bustle area)	18	58.1%

Table 27

Number of Soldiers With Scorer Agreements in Three Categories of Tank Exposure Using Tape Method and Profile Overlay Method of Determining Tank Exposure on Hull Defilade Test

Outcome	Tape Method[a]	Profile Right	Overlay Left	Method[a] Either
Turret and Hull Concealed	1	6	1	0
Turret Exposed, Hull Concealed	13	12	16	16
Turret and Hull Exposed	8	2	6	8
Total Agreement Percent[a]	71.0%	64.5%	74.2%	77.4%

[a]N=31.

complex. Unlike the Missile, Duck test, Hull Defilade requires some exposure of the turret. Scoring complexity is compounded if the present two-profile diagram is retained. The continued use of this method is not recommended for this test; however, it is recommended that the utility of the method or some variation be further explored.

Problems with tape durability and visibility similar to those experienced on the Missile, Duck test occurred with this test. The hull defilade position was adequate for the requirement but two cautions are necessary for future test applications. First, only one adequate hull defilade position can be located in the immediate area if accurate off-tank scoring is to be achieved. Second, foliage at the hull defilade position must be minimal. In scoring, foliage concealing the hull is not distinguished from hull cover. Foliage concealing the turret can also result in scoring the turret as covered (i.e., an inadequate position) while from the tank position the field of fire is inadequate.

Somewhat unexpectedly, OSUT soldiers appeared to have fewer problems with the concept of Hull Defilade than they did with the concept of Missile, Duck. And as with the Missile, Duck test, enough variation was observed in performance to conclude that tracking previous performers into the hull defilade position was not widespread. Again, with more experienced drivers this latter occurrence cannot be ruled out.

One further requirement to simplify the test administration process is the need for an enemy tank silhouette target for the driver to identify. While realism dictates that the driver will not always see the target, the test requirement that no detailed guidance be given the driver in the hull defilade position requires that some visual cue be offered.

Test Intercorrelations

A final set of analyses concerned the extent to which the tests and the variables within tests tended to measure independent driving abilities. Each variable was scored according to the recommendations in the previous sections. Among the 4 tests administered on the first occasion, 19 measures were retained; among the 5 tests administered on the second occasion, 17

measures were retained (see Table 28). Intercorrelations were then computed among all variables in each set. Kendall correlations were used because so many of the variables (14 in the first set, 11 in the second) had severely restricted ranges of possible values. Because the null hypotheses postulated that relationships do exist, and the research hypotheses were that the behaviors are independent, the protection (significance) levels of the correlations begin at .10. On variables scored by two observers, cases were included in the computations only when the observers' scores agreed. The two correlation matrices are presented in Tables 29 and 30.

In the first set of correlations, 45 of the 171 (26.3 percent) coefficients were statistically significant. However, 8 of the 45 are correlated because of algebraic interdependence: On the test Follow Ground Guide Signals, strikes before, during, and after the turn are components of total strikes and are, of course, correlated with total strikes; likewise on Right and Left Turns, strikes before, during and after[1] are correlated with total right and left turn performances. Overall, there are 13 variables that are scored either as no strike/strike or as no strike/one strike/two or more strikes, yielding 70 algebraically independent correlations; of these, only 5 (7.1 percent) are statistically significant. Thus the various measures of driving ability in terms of barrier strikes, counted during the Follow Ground Guide Signals and Right and Left Turns tests, appear to be modestly related at best. No consistent patterns emerged to suggest dropping any of the measures as redundant. Barrier strikes counted on the Align Tank for Width test were not correlated with any of the other measures of strikes.

The three measures of time from the Follow Ground Guide Signals and Right and Left Turns tests were all intercorrelated, indicating that soldiers tended to be consistent in their driving speed across tests. On the Follow Ground Guide Signals test, time was related to barrier strikes after the turn, and for both the left turn and the right turn the time and several of the strike measures were significantly correlated, with soldiers who struck the barrier requiring more time to perform. Thus time probably does not reflect careful driving throughout the turn, but may reflect careful driving in reaction to barrier strikes having occurred.

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[1]Right turn only; no strikes were recorded after the turn on the left turn.

The two measures of length of the turn from the Right and Left Turns test were correlated with each other, and correlated negatively with the time measures. Additionally, strikes during the right turn were correlated with both length measures. Overall, the three-way pattern is that soldiers with barrier strikes took more time but had a shorter turn radius than did soldiers with no barrier strikes.

The pattern is reversed when barrier strikes on the Align Tank for Width test are analyzed with the Right and Left Turns time and length measures. Significant correlations indicate that soldiers with barrier strikes on Align Tank for Width required less time and had longer turn radii on Right and Left Turns than did soldiers with no barrier strikes. Clearly the observations of barrier strikes on Align Tank for Width and on Right and Left Turns are indications of different dimensions of driving ability.

The number of correct decisions on the Width Judgment test was not consistently related to any other measures. Of the 13 such measures obtained, significant correlations occurred with two measures of barrier strikes. Both correlations were such that more correct decisions were associated with more strikes. Correct decisions were also significantly correlated with the length of the right turn, the shorter lengths being associated with more correct decisions. In general, it appears that the perceptual-cognitive skill involved in the width judgments is independent of the perceptual-motor skill involved in the other Obstacle/Judgment tests.

Of the 120 correlations in the second set of analyses, 44 (36.7 percent) were statistically significant. Unlike the Width Judgment test analyzed with the first set of tests, the number of correct decisions on the Height Judgment test was significantly correlated with 5 of the tactical driving measures: number of transmission shifts on the Control Tank During Main Gun Engagement (but note that N = 4), time and the TC evaluations of speed and timing on the Missile, Duck test, and concealment measured by the profile method on the Missile, Duck test. In all cases, more corrct decisions are associated with the desirable ("correct") rating (fewer shifts, less time, speed fast enough, timing immediate, fully concealed).

On the test Control Tank During Main Gun Engagement, time and number of transmission shifts were positively correlated, based on the eight soldiers for whom shift counts were obtained. Time was also correlated with time measures on the Acceleration and Stopping test and the Hull Defilade test, and with the timing rating, but not actual time, on the Missile, Duck test. The number of shifts was correlated with the three movement measures on the Missile, Duck test (speed, timing, and time) for the eight soldiers scored. Thus the Control Tank test skills assessed here may be redundant with the movement skills of the Missile, Duck test, although further data collection is required to ensure the replicability of these findings.

Within the Acceleration and Stopping test, time and distance from the finish line were positively correlated, as were distance and the stopping evaluation--a smooth stop associated with finishing close to the line--although time and the stopping evaluation were not related. The interpretation is that the soldiers who stop smoothly also stop close to the line, and the soldiers who finish closest to the line also finish most quickly. But because the correlations are not perfect the smooth stop is not an indicator of fast or slow performance. The three measures have scattered correlations with measures of the Missile, Duck test: time with the timing rating and one method of rating concealment, distance with the speed rating, and the stopping evaluation with the tape method of rating concealment. In addition, the time for the Acceleration and Stopping test was positively correlated (i.e., in the desirable direction) with all ratings in the Hull Defilade test, while the measure of distance from the finish line was correlated with two of the methods of rating hull concealment. Further data collection should be initiated to determine whether or not the Acceleration and Stopping test measures driving abilities that are independent of those measured during the Missile, Duck and Hull Defilade tests.

The Missile, Duck test appears to consist of two kinds of measured skills: movement and concealment. The speed, timing, and time measures were significantly intercorrelated, and the tape method and profile method of assessing concealment were intercorrelated. Timing was also related to one of the concealment ratings (immediate reaction and more complete

concealment), which is a slight indication that the two areas may have some common underlying ability; this may be little more than understanding the concept of the task.

On the Hull Defilade test, the three measures of concealment--tape method, profile method, and TC evaluation of mask clearance--were likewise intercorrelated, but speed and time were not. Time was correlated with two of the concealment measures, with soldiers requiring less time to achieve a correct position (hull concealed, turret exposed). The TC ratings of speed and mask clearance were also correlated. In contrast to the Missile, Duck test, it appears that the movement and concealment abilities are more strongly interdependent in the Hull Defilade test.

Intercorrelations between the two tests are inconsistent. Of the six correlations amoung measures of concealment, only two were significant despite strong within-test correlations. Time on Hull Defilade was correlated with both timing and time on Missile, Duck, but the two ratings of speed were not correlatd. Strangely, soldiers who required less time on Missile, Duck were rated as too slow on Hull Defilade.

In summary, the two sets of intercorrelations indicate that the Obstacle/Judgment tests are probably independent. Although the four tests are undoubtedly measuring some common dimensions of driving ability, the tests are sufficiently different to warrant continued use of all four. Whether or not the fifth test, Height Judgment, is related to the four tested earlier cannot be determined. Among the Tactical Driving tests, there is some evidence that the skill measures on the tests of Control Tank During Main Gun Engagement and Acceleration and Stopping are not assessing unique skills, but have much in common with the movement ratings on the Missile, Duck and Hull Defilade tests. Neither set of measures may be substituted for the other, however, and more success in obtaining data on the Control Tank test may reveal that the tests are as different as their titles suggest.

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DISCUSSION

The measurement of nonprocedural driving skills is made more difficult by a lack of clear designation of the scope of driver tasks. The approach taken in this research has been to define driver tasks in somewhat arbitrary and sometimes artifical terms. This was necessary because of the requirement to isolate certain behaviors for measurement. While the selection of these behaviors was based on a certain amount of analysis and attention to what can reasonably be expected of drivers in the field, the end products are certainly neither inclusive of all desired behaivors nor are they probably universally acceptable as the definition of the driver job. Therefore several cautions are needed:

- The tests and test titles should not be construed as a redefinition or new assignment of driver tasks. Behaviors have been grouped under similar functional areas and in some cases (i.e., Missile, Duck; Hull Defilade, Main Gun Engagement) they are tested in a partial tactical context. Although a broader defininition of the driver's job (beyond the procedural tasks) may be a requirement, that was not the goal of this research effort.

- Crew interaction was not a consideration in the testing. The existence of and necessity for TC, gunner and even loader interaction with the driver is fully recognized. But the extent of that interaction requires a complex team task analysis beyond the scope of this work. For purposes of evaluation it was necessary to isolate the driver's behavior by excluding any TC or other interacton during the test even though this might make the tested behavior inconsistent with job requirements. It is the inconsistency of interaction from crew to crew and the inability to be definitive about the extent of interaction that made this necessary. Although the criticism that the tests require more than is required of drivers on the job is not lightly dismissed, it is nevertheless maintained that drivers who are capable of performing with minimal interaction are potentially better drivers, regardless of the latitude or direction they are actually given during on-the-job performance.

- While the tests were to be developed as criterion tests, the effort to date has not established criterion standards. The limited sample tested consisted of OSUT personnel only. While it may be desirable to establish performance standards for this level of driver, no data were gathered on the learning effect on the test itself.

> One caution that will affect standards establishment is the effect of the test conditions (terrain, weather, surface conditions, vehicle conditions) wherever the test is applied in the future. These variables may ultimately prove to be an insurmountable obstacle to establishing an absolute standard for some measures.

Although the purpose of this research was not to develop operational tests for general field application, the benefits of using these tests in that capacity should not be ignored. The primary benefit is that the tests focus on nonprocedural aspects of the driver's job and this is a neglected area in current field driver evaluation situations. Additionally, the tests are fairly inexpensive to administer and are easy to score. The main caution is that in field units, they should be used primarily in a training mode. Currently they are not intended as GO-NO GO scored tests because of the absence of evaluative standards discussed earlier. Only normative scores may be obtained as the tests are now configured. These may be applied to compare drivers within a unit (platoon or company) or to measure the same driver's performance over time in repeat applications of the test.

The major effort of this research has been to focus primarily on the development of reliable performance measures as a necessary initial step in establishing measurement criteria. Assessment of reliability is the most crucial aspect of instrument development. Without reliability there can be no test validity and all instrument refinement, test and administration, scorer training and conditions specifications must concentrate on increasing reliability. Unless scoring reliability has been established, any further application of the instruments is a needless waste of resources. Based, however, on the initial results and recommended modifications there is ample evidence that these tests hold promise as reliable quantitative instruments for measuring performance and producing criteria to use in yardstick comparisons with simulator-measured skills. While more replications and developmental refinements of the test are needed before measurement can be applied against a simulator, the tests contained in Appendix A and as modified in the Results section should provide the basis for that refinement.

It must be recognized that while the tests as constructed appear to give a good representative coverage of many nonprocedural driving skills, this research effort has not attempted to analyze all nonprocedural driving tasks to insure comprehensive coverage. It is likely that if comprehensive measurement of driver skills is to be obtained, more tests or scored events will have to be added to the test package. Two cautions are necessary if such effort is to be undertaken. First is the requirement to obtain empirical data to ascertain whether or not measures are redundant across tests. Second is to remain within feasibility constraints for administration. Already the existing package of tests strain the abilities of a unit to support. For example, to administer the existing tests to more experienced drivers--assuming the desired number of drivers was approximately 30--would require the commitment of an operational tank battalion for a minimum of two days.

Effort must continue on the reliability issue, both to ensure that reliability remains high on the measures selected and to increase reliability on other desired measures. Obviously one method, discussed earlier, is to ensure that future replications allow time, equipment and personnel availability to permit comprehensive scorer training concentrating on the areas of difficulty specified in the Results section of this report. However, the most promising path to increased reliability is to look for ways to replace human judgment. Early in this effort, automated scoring was considered and although availability of operational tanks and adequate test personnel precluded tryout, enough preliminary information was gathered to indicate promise in this area. Such automated scoring devices as photo electric cells, engine monitors, TV recorders and hand-held data recorders could supplement or in some cases replace scorer judgment on selected measures. This area is important to consider, particularly in those tests where many measures occur in an extremely short period of time such as in many of the Tactical tests.

As confidence is being established in the reliability of the tests, future efforts must also address the validity issue. Normally, in performance tests the validity issue depends on how closely by the test situation approximates the "real life" situation. As has been discussed, the tests

administered vary considerably from what the driver may do on the job--the inability to define precisely the driver's job role as being part of the test development problem. Therefore the validity problem remains an issue. Specifically the validity problems are:

- Construct validity: To what extent has the intended construct (e.g., judgment, speed control) actually been measured? On most measures construct validity is not a paramount question; common sense review indicates what is being measured. But contamination on other measures can only be ruled out if dissimilar methods of measurement are applied.

- Content validity: To what extent do the measures or even the tests themselves represent "driving skill?" This issue is doubly bothersome because of the lack of a clear definition for driving skill. Investigation of content validity could be pursued along the lines of critical incident criteria by matching test measures or events against a field-generated list of driving occurrences.

- Predictive Validity: To what extent would the driving performance on the tests correlate with a direct measure of driving performance? This question is important if the tests are to continue to be used on OSUT level drivers but the problem of identifying "successful" driving performance consistently and objectively remains.

RECOMMENDATIONS

This research has established a methodology for test development to serve as the basis for identifying and measuring driver skills. It has established a core of reliable test instruments to measure specific and supporting driving skills and to serve as a measure of simulator skills. But further efforts in this area are warranted; specifically further research is recommended to accomplish the following:

- Resolve validity questions by exploring other aspects of tank driving skill measurement and evaluation.
- Administer the existing tests to more experienced drivers to obtain performance data on other than a novice group.
- Continue to explore the domain of "driving skill," adding or modifying tests as needed to increase coverage.
- Explore the possibilities of automated scoring to replace or supplement judgmental scoring.

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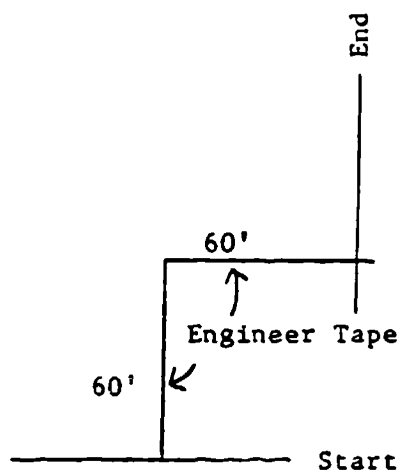
APPENDIX A

DRIVER PERFORMANCE TESTS

FOLLOW GROUND GUIDE SIGNALS

TEST CONDITIONS: Conducted on hard surface with one side marked with engineer tape. (NOTE: The same site that is used for Right and Left Turns may be used.) Pylons or stakes should be set up a distance of 18' out from the turn and the entrance and exit width set at 13'.



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
130' engineer tape
6 - 5' stakes or pylons
4 - 2' stakes
1 - stopwatch
50' measuring tape

Personnel:

1 TC
1 Scorer
2 Ground Guides

TEST PREPARATION:

1. Erect the engineer tape along the inside (right hand) of the lane.

2. Place pylons or stakes at a distance of 13' at the entrance and exit points and 18' out from the 90° turn.

TEST ADMINISTRATION (TC):

1. Back the tank up to the starting point and positioned within one foot of the engineer tape.

2. Read the instructions to the driver before mounting the tank.

3. Do not give any assistance or guidance to the driver during the test. No scoring is required from the TC.

TEST ADMINISTRATION (GROUND GUIDES):

1. One ground guide is positioned in the rear of the tank; the other provides the signals to the driver.

2. The first signal given will be to start the tank.

3. Give ground guide signals as necessary to get the tank through the course keeping the tank as close as possible (within two inches except at the turn) without striking the tape.

4. If you give an incorrect signal causing the tank to touch any of the barriers, notify the scorer.

TEST ADMINISTRATION AND SCORING (GROUND OBSERVER):

1. Start timing when the ground guide gives the first signal. Stop timing when the front of the tank clears the end point.

2. Record each time any part of the tank touches the engineer tape, stakes or pylons.

3. If there was a barrier strike caused by an incorrect ground guide signal do not count this as a barrier strike.

INSTRUCTIONS TO DRIVER: During this test you will drive the tank following a ground guide. You will be required to back the tank as the ground guide directs. Leave your hatch open. Are there any questions?

SCORESHEET

FOLLOW GROUND GUIDE SIGNALS

Examinee Name: ____________________ Date & Time: ____________________

Trial Number: ____________________ TC: ____________________

Scorer: ____________________

MEASURES:

1. Number of barrier strikes:

   Before turn _____ During turn _____ After turn _____

2. Time: ________________

COMMENTS: ____

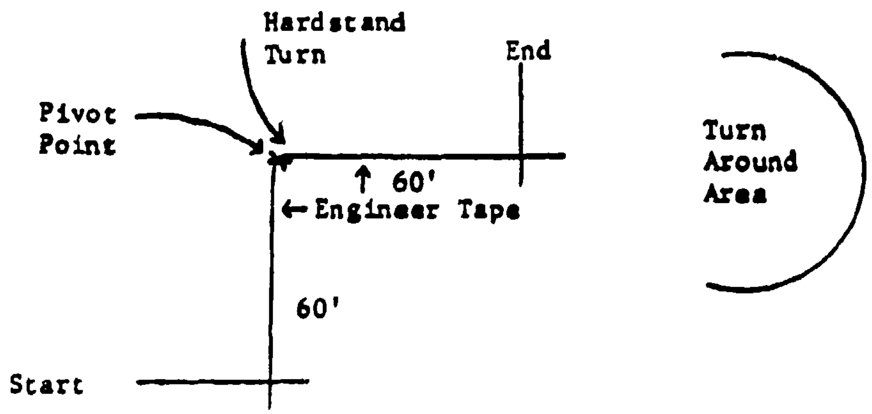
________________ ____

____

____

RIGHT AND LEFT TURNS

TEST CONDITIONS: A hardstand allowing a right/left angle is required. An approach and exit "lane" each approximately 20 meters long is required and a turnaround area after the end point is required, i.e., (Note: The same site that is used for Follow Ground Guide Signals can be used.)



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
130' engineer tape
6 - 5' stakes or pylons
4 - 2' stakes
50' measuring tape
1 - stopwatch
1 - broom

Personnel:

1 TC
2 Scorers

TEST PREPARATION:

1. Erect the engineer tape on stakes or pylons on the inside of the turn at or slightly below fender height. The tape must make a 90° angle at the pivot point.

2. Mark the start and end points with stakes and engineer tape.

3. Spread a light covering of dirt over the hardstand at the turn to assist in scoring the radius of the turn.

TEST ADMINISTRATION (TC):

1. Position the tank, engine off, at the start point.

2. Read the instructions to the driver before mounting the tank.

3. When the driver has started the tank, command DRIVER, MOVE OUT and signal the scorer.

4. If necessary, assist or direct the driver in turning around after he has passed the end point.

5. Direct the driver to stop at the "end" point after the turn around.

6. Command DRIVER, MOVE OUT and signal the scorer.

7. If the driver asks if he should pivot turn tell him he may.

8. Do not assist the driver in making the turn. No scoring is required from the TC.

TEST ADMINISTRATION AND SCORING (GROUND OBSERVERS):

1. Position one scorer on the inside (engineer tape side) of the lane and the other on the outside.

2. One scorer must keep track of time. Start the time when the TC signals and stop the time when the rear of the tank clears the end point.

3. The inside scorer will observe and record any time the tank touches the engineer tape or stakes.

4. The outside scorer will mark the widest point reached by the rear of the track on the turn.

5. Measure the distance from the pivot point to the widest point reached on the turn.

6. Sweep dirt over the turn to assist in scoring the left turn.

7. Repeat the scoring process for the left turn.

INSTRUCTIONS TO THE DRIVER: During this test you must drive this lane staying as close as possible to the engineer tape without hitting the tape. After you complete the first run we will turn the tank around and you must complete the course again from the opposite direction. I will not be able to assist you during the course. You will drive with your hatch open. Do you have any questions?

SCORESHEET

RIGHT AND LEFT TURNS

Examinee Name: ____________________ Date & Time: ____________________

Trial Number: ____________________ TC: ____________________

Scorer(s): ____________________

MEASURES:

RIGHT TURN

Radius of right turn: ________________

Did tank touch engineer tape: YES NO

If YES was it: Before Turn ____ During Turn ____ After Turn ____

Time: ________________

LEFT TURN

Radius of left turn: ________________

Did tank touch engineer tape: YES NO

If YES was it: Before Turn ____ During Turn ____ After Turn ____

Time: ________________

COMMENTS: ____

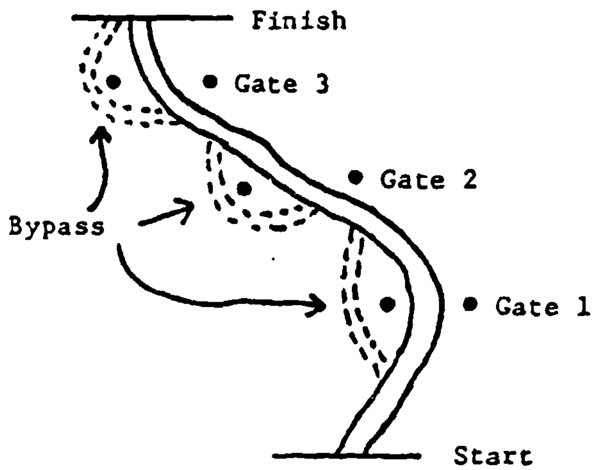
____

____

____

WIDTH JUDGMENT

TEST CONDITIONS: Test is conducted in open terrain with three sets of pylons or portable stakes set up at approximately 50' intervals and offset. There must be sufficient room to bypass each set of width markers. Markers must be movable so that adjustments can be made between tests. Markers will be set up at widths of 157", 169", and 144".



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
20' engineer tape
4 - 2' stakes
6 - 5' stakes or pylons
50' measuring tape
1 - stopwatch

Personnel:

1 TC
1 Scorer

TEST PREPARATION:

1. Set up the three sets of gates at widths of 157", 169" and 144". Set up the gates so that all three are not in a straight line.

2. Mark a start and finish point with the short stakes.

3. Drive each bypass area at least once to mark it.

4. Vary the width of each gate after each run using the same three widths but moving the location, i.e., if Gate 1 was 144" for the first run it should be adjusted to 169" for the second examinee and so on.

TEST ADMINISTRATION (TC):

1. Position the tank, engine off, at the start point.

2. Read the instructions to the driver before mounting the tank.

3. When the driver has started the tank command DRIVER, MOVE OUT and signal the scorer.

4. Do not assist the driver in deciding whether to pass through the gates or during the passage. No TC scoring is required.

5. If the driver pulls up to a gate and then decides he wants to bypass, you may assist him in backing up.

TEST ADMINISTRATION AND SCORING (GROUND OBSERVER):

1. Mark the width of each of the gates on the scoresheet.

2. Position yourself where you can observe all three gates and the finish point.

3. Start the time when the TC signals and stop the time when the rear of the tank passes the finish point.

4. Record for each gate whether the driver passed through or bypassed. Circle for each gate whether the tank cleared the gate. If any part of the tank touches the stake or pylons, circle NO. If the gate was bypassed circle NA.

5. Adjust the width of at least two of the gates after each run. One of the two must be the narrowest gate (144"). The width of the gates must be exact for each run. Use an assistant or the TC to help adjust the width.

INSTRUCTIONS TO THE DRIVER: During this test you must judge whether you can pass through three openings. If you think you can pass, drive the tank between the pylons (or stakes) without hitting them. If you think it is too narrow, you must drive around to the (right or left). I cannot help you in making the decision or driving between the markers. You will drive open hatch. Do you have any questions?

SCORESHEET

WIDTH JUDGMENT

Examinee Name: ____________________ Date & Time: ____________________

Trial Number: ____________________ TC: ____________________

Scorer(s): ____________________

MEASURES:

GATE 1 Width: ____________

1. Passed through _____ Bypassed _____

2. Cleared Gates: YES _____ NO _____ NA _____

GATE 2 Width: ____________

1. Passed through _____ Bypassed _____

2. Cleared Gates: YES _____ NO _____ NA _____

GATE 3 Width: ____________

1. Passed through _____ Bypassed _____

2. Cleared Gates: YES _____ NO _____ NA _____

Time: ______________

COMMENTS: ____

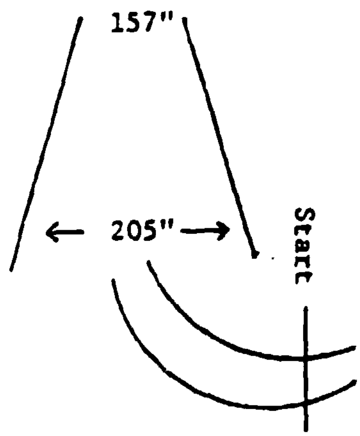
____

____

____

ALIGN TANK FOR WIDTH

TEST CONDITIONS: A hardstand area approximately 20 meters long is required marked on both sides with pylons/engineer tape. The lane starts at 205" and narrows to 157" at the exit end. A start area not aligned with the lane is required.



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
130' engineer tape
6-9 - 5' stakes or pylons
2 - 2' stakes
1 - stopwatch
Felt marker
50' measuring tape

Personnel:

1 TC
2 Scorers

TEST PREPARATION:

1. Erect the engineer tape on both sides of the lane so that it measures 205" wide at the wide end and narrows to 157" wide at the exit end. Tape must be at or slightly below fender level.

2. Mark the engineer tape in quarters each approximately 15' long.

3. Select a start point that is not aligned with the entrance to the course and mark with the short stakes and engineer tape.

TEST ADMINISTRATION (TC):

1. Position the tank, engine off, at the start point.

2. Read the instructions to the driver before mounting the tank.

3. When the driver has started the tank, command DRIVER, MOVE OUT and signal the scorer.

4. Do not assist the driver in maneuver during the course <u>except</u> if he has to back up to correct his alignment. You may then assist him by directing him to stop before he backs into the engineer tape barrier. Inform the scorer after the run that you assisted in backing.

5. No scoring is required by the TC.

TEST ADMINISTRATION AND SCORING (GROUND OBSERVER):

1. Position one scorer on each side of the lane.

2. One scorer must keep track of time. Start the time when the TC signals and stop the time when the rear of the tank clears the narrow end of the engineer tape.

3. Record the number of times any part of the tank touches the engineer tape or stakes.

4. Record the distance of each strike by circling Brief or Sustained. A Brief strike is a distance of two feet or less; a Sustained strike is more than two feet.

5. For each strike circle the part of the tank (Front, Rear or Entire Side) that touches the barrier. Circle the location of the strike as 1, 2, 3 or 4 based on which quarter of the lane it occurred in (1st quarter is at the wide end; 4th quarter at the narrow end).

INSTRUCTIONS TO THE DRIVER: During this test you must navigate the passage without striking the stakes or engineer tape. I will not assist you in lining up the tank. You will drive with the hatch open. Do you have any questions?

SCORESHEET

ALIGN TANK FOR WIDTH

Examinee Name: ______________________ Date & Time: ______________________

Trial Number: ______________________ TC: ______________________

Scorer: ______________________

MEASURES:

RIGHT SIDE

Number of barrier strikes: ____________

For each strike, describe:

1. Brief	Sustained	Front	Rear	Entire Side	Location: 1 2 3 4
2. Brief	Sustained	Front	Rear	Entire Side	Location: 1 2 3 4
3. Brief	Sustained	Front	Rear	Entire Side	Location: 1 2 3 4
4. Brief	Sustained	Front	Rear	Entire Side	Location: 1 2 3 4
5. Brief	Sustained	Front	Rear	Entire Side	Location: 1 2 3 4

Time: ____________

COMMENTS: ____

SCORESHEET

ALIGN TANK FOR WIDTH

Examinee Name: ______________ Date & Time: ______________

Trial Number: ______________ TC: ______________

Scorer: ______________

MEASURES:

LEFT SIDE

Number of barrier strikes: ______________

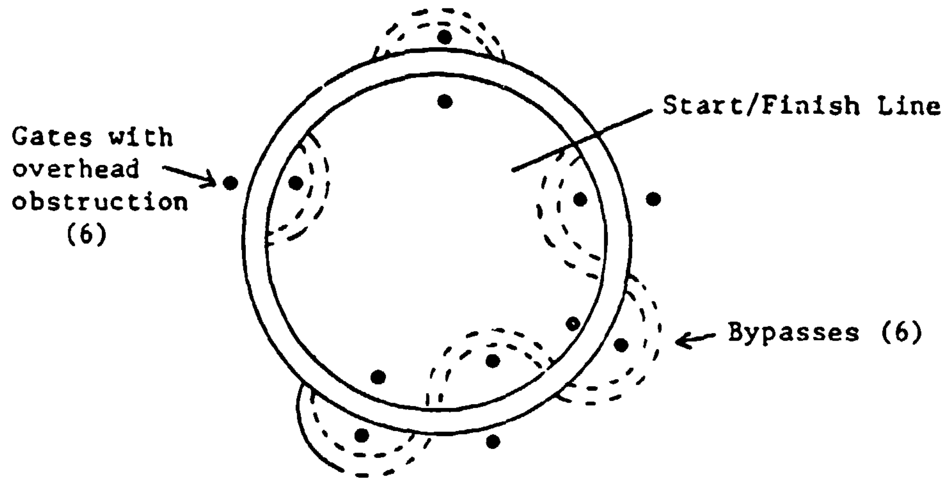
For each strike, describe:

1.	Brief	Sustained	Front	Rear	Entire Side	Location: 1 2 3 4
2.	Brief	Sustained	Front	Rear	Entire Side	Location: 1 2 3 4
3.	Brief	Sustained	Front	Rear	Entire Side	Location: 1 2 3 4
4.	Brief	Sustained	Front	Rear	Entire Side	Location: 1 2 3 4
5.	Brief	Sustained	Front	Rear	Entire Side	Location: 1 2 3 4

Time: ______________

COMMENTS: ____

TEST CONDITIONS: A hardstand area with a series of six overhead gates and room to bypass each set of gates, i.e.,



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
2 - 24" stakes
10' engineer tape
6 - gates each consisting of
2 - 2x4 uprights 12'-14' long
and connecting material
that is adjustable in height
1 - Stopwatch
1 - 50' measuring tape
6 - 2" x 2' cards numbered 1 through 6

Personnel:

1 TC
1 Scorer

TEST PREPARATION:

1. Erect the six gates at points equidistant around the course.

a. Set the gates at a width of 170".

b. Set the overhead obstructions at the following heights in random order.

(1) 119"
(2) 118"
(3) 117"
(4) 116"
(5) 115"
(6) 114"

c. Affix a number card to each set of gates.

2. Mark the Start/Finish Line with stakes/engineer tape.

3. Drive through the course and through each bypass at least once so that bypass lanes are marked.

4. Change the location of the height of the gates between each examinee and unobserved by the examinee. Change the height of at least two gates; one of which must always be the 114" gate. The measurement for the height of each gate must be exact and must be of the six heights specified above.

TEST ADMINISTRATION (TC):

1. Position the tank, engine off, at the Start/Finish Line with gun tube to the rear.

2. Remove the antenna(s).

3. Read the instructions to the examinee before mounting the tank.

4. Adjust the TC hatch to the protected open position. (NOTE: The TC may choose to ride in the loader's position for better vision and control.)

5. When the driver has started the engine, command DRIVER, MOVE OUT and signal the scorer.

6. Do not assist the driver in making the decision about passing or bypassing the gate. You may stop and correct the driver if you see that he is going to strike one of the uprights. If this happens you must inform the scorer.

7. If the driver pulls up to a gate and then decides to bypass, you may assist him in backing up. However, the decision to bypass must be made by the driver alone.

TEST ADMINISTRATION AND SCORING (GROUND OBSERVER):

1. Write down the height for each one of the gates on the scoresheet.

2. Start timing when the TC signals and stop when the rear of the tank crosses the Start/Finish Line.

3. Position yourself where you can observe each gate. Mark on the scoresheet whether the drive passed or bypassed each gate.

4. If any part of the tank touches any of the uprights or if the TC had to interfere with the driver to avoid striking an upright, note the gate and what occurred in the Comments section of the scoresheet.

5. After each examinee, change the location of the 114" overhead obstruction and at least one other obstruction height. However, all six heights must be consistently maintained.

INSTRUCTIONS TO DRIVER: At this station you will be tested on judging and navigating overhead obstacles. You must decide if the tank can safely pass under each obstacle. If you decide it can you must drive underneath the obstacle. If you decide the tank cannot pass underneath the obstacle you must bypass it to the right or to the left. The antennas have been removed and the TC hatch is open in the protected position. You will have your hatch open. I cannot help you in deciding whether you can clear the obstacle or not. Do you have any questions?

SCORESHEET

HEIGHT JUDGMENT

Examinee Name: ______________________ Date & Time: ______________________

Trial Number: ______________________ TC: ______________________

Scorer: ______________________

MEASURES:

GATE 1 Height: ____________

Bypass: YES NO

GATE 2 Height: ____________

Bypass: YES NO

GATE 3 Height: ____________

Bypass: YES NO

GATE 4 Height: ____________

Bypass: YES NO

GATE 5 Height: ____________

Bypass: YES NO

GATE 6 Height: ____________

Bypass: YES NO

COMMENTS: ____

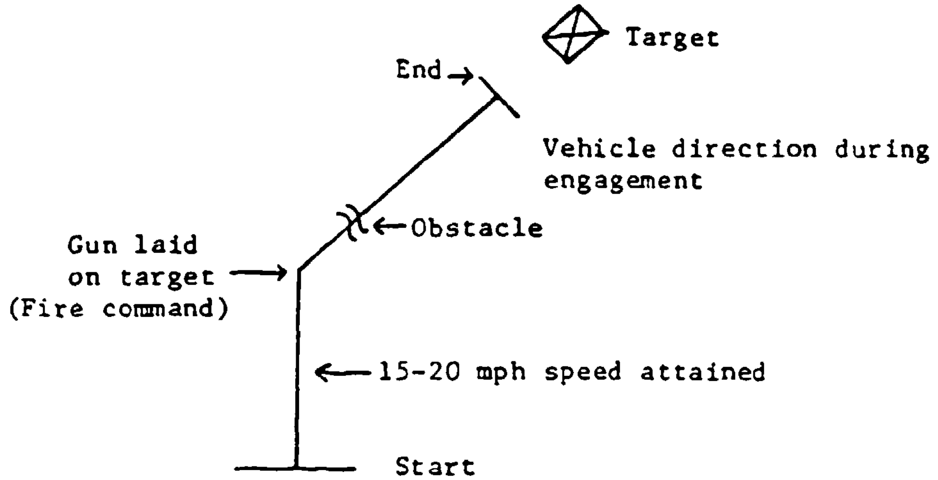
____

____

____

CONTROL TANK DURING MAIN GUN ENGAGEMENT

TEST CONDITIONS: Terrain allowing tank speed of 15-20 mph and an area at least 250 meters long is required for the test. At least part of the terrain (during the engagement portion) must be off road. An obstacle (ditch or other obstruction) which can be bypassed is located in the vehicle path. A target should be placed to facilitate laying the gun and evaluating the driving. The target should be located approximately 30° off the initial direction of travel, approximately 500 meters from the vehicle path in a location that can be viewed continuously from the gunner's position.



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

- 1 - M1 tank
- Target, 24" x 24"
- 1 - stopwatch
- 6 - 2' stakes
- 20' engineer tape
- 2 - 2" x 2" x 8' stakes

Personnel:

- 1 TC
- 1 Gunner

TEST PREPARATION:

1. Set up the 24" x 24" panel at a distance of approximately 500 meters. Insure that the panel can be observed from the fire command issue point on.

2. Mark the start point, the end point and the point where the fire command will be issued.

3. If an obstacle does not naturally exist, construct one out of logs, dirt or a ditch that will require that the driver to alter course.

TEST ADMINISTRATION AND SCORING (TC):

1. Position the tank, engine off, at the start point. Center the gun tube over the front slope.

2. Read the instructions to the driver before mounting the tank.

3. Insure the driver has his hatch locked before starting the test.

4. When the driver reaches the point for issuing the command, issue a fire command. Start timing on the alert element GUNNER.

5. When the driver reaches the stop point announce CEASE FIRE and stop timing.

6. If the driver does not reach an estimated 15 mph before the location for issuing the fire command, tell him to speed up.

7. Count the number of times that the transmission shifted up or down between the alert element of the fire command and CEASE FIRE and enter it on the scoresheet. Do this without consulting with the gunner.

TEST ADMINISTRATION AND SCORING (GUNNER):

1. Announce IDENTIFIED as soon as the TC lays you on the target.

2. Attempt to maintain the cross hairs on the 24" x 24" panel from IDENTIFIED until CEASE FIRE. Estimate the percent of time you were able to keep the crosshairs on the target and mark it on the scoresheet.

3. Count the number of times that the transmission shifted up or down between the alert element of the fire command and CEASE FIRE and enter it on the scoresheet. Do this without consulting with the TC.

SCORESHEET

CONTROL TANK DURING MAIN GUN ENGAGEMENT

TC EVALUATION

Examinee Name: ____________________ Date & Time: ____________________

Trial Number: ____________________ TC: ____________________

Scorer: ____________________

INSTRUCTIONS TO DRIVER: During this test you will drive the vehicle during a moving main gun engagement. You must have your hatch closed. You must keep the front of the tank oriented on the enemy location. The required speed is 15-20 mph. Do you have any questions?

MEASURES:

1. Oriented the front of the tank towards the enemy. YES NO
2. Avoided obstacle. YES NO
3. Announced turn to avoid obstacle. YES NO
4. Reoriented tank toward target after passing obstacle. YES NO
5. Number of times that transmission shifted after fire command: ________
6. Time from alert element to CEASE FIRE: ____________

COMMENTS: ____

____

____

____

SCORESHEET

CONTROL TANK DURING MAIN GUN ENGAGEMENT

GUNNER EVALUATION

Examinee Name: ______________________ Date & Time: ______________________

Trial Number: ______________________ Gunner: ______________________

Scorer: ______________________

MEASURES:

1. Percent of time after fire command that reticle was on target:

   100 75 50 25 0

2. Number of times that transmission shifted after fire command: ______

COMMENTS: ____

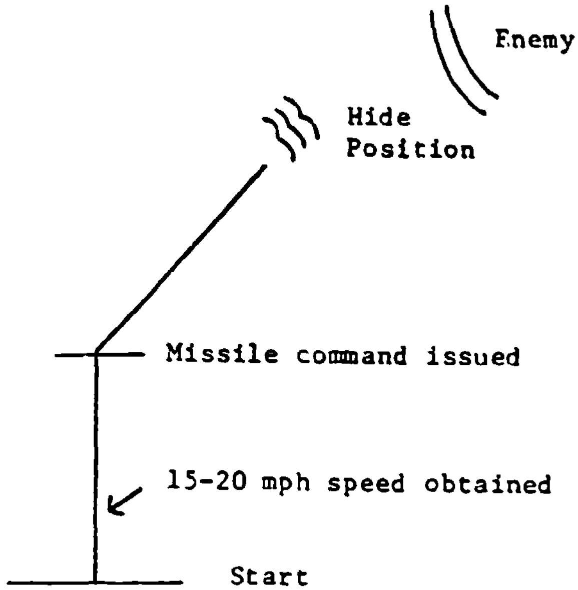
____

____

____

REACT TO TC COMMAND - MISSILE, DUCK

TEST CONDITIONS: Terrain allowing tank speed of 15-20 mph and an area approximately 200 meters long and 50 meters wide is required. At least one adequate hide position is required which must be visible during the approach portion of the driving.



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
Tape, adhesive, 1', yellow
1 - binoculars
4 - 2' stakes
1 - stopwatch
20' engineer tape

Personnel:

1 TC
1 Scorer

TEST PREPARATION:

1. Select an enemy location that is visible from the start point and from the hide position. The enemy location should be a minimum of 500 meters from the hide position.

2. Mark the start point with a stakes and engineer tape.

3. Identify a location for issuing the command. This location should be far enough from the start point to allow the driver to reach 15-20 mph and about 10-12 seconds from the nearest acceptable position, and visible from the enemy location. If the location is not marked naturally (such as by a tree), mark the location with stakes and engineer tape.

4. Place two-foot long segments of adhesive tape horizontally at intervals on the turret in three rows: at the bottom, in the middle, and at the top of the turret. Do the same on the hull.

TEST ADMINISTRATION AND SCORING (TC):

1. Position the tank, engine off, at the start point.

2. Read the instructions to the driver before mounting the tank.

3. Insure the driver has the hatch closed before starting the test.

4. When the driver reaches the location for issuing the command, announce MISSILE, DUCK. Begin timing.

5. If the driver does not reach an estimated 15 mph before the location for the announcement, tell him to speed up.

6. When the driver reaches his final position, stop timing and signal the observer.

7. Do not assist the driver in moving to or into the hide position.

TEST ADMINISTRATION AND SCORING (OBSERVER):

1. Select and mark a position at the enemy location. Use this position each time the test is run. If at 500 meters or less, always observe in the same body position, i.e., standing, kneeling or sitting.

2. Observe the tank through the binoculars. When the TC signals that the driver is in the final position, count the number of tape segments visible on the turret and on the hull.

3. Using the tank pictures on the scoresheet, outline the portion of the tank that is visible.

4. Rate the amount of exposure after the initial stop and after the TC's signal that the driver is in the final position.

SCORESHEET

REACT TO TC COMMAND - MISSILE, DUCK

TC EVALUATION

Examinee Name: ____________________ Date & Time: ____________________

Trial Number: ____________________ TC: ____________________

Scorer: ____________________

INSTRUCTIONS TO DRIVER: During this test you must react to a command given by the TC. The __________ (indicate location) is a suspected enemy location. You must operate with your hatch closed and at an initial speed of 15-20 mph. Once I issue you the command I will not assist you in following the command. Do you have any questions?

MEASURES:

1. Which describes the acceleration after the command? (Circle one)

   Speed: Fast Enough Too Slow

   Timing: Immediate Delayed

2. Time from command to final position: __________

COMMENTS: ____

____

____

____

SCORESHEET

REACT TO TC COMMAND - MISSILE, DUCK

OBSERVER EVALUATION

Examinee Name: ____________________ Date & Time: ____________________

Trial Number: ____________________ TC: ____________________

Scorer: ____________________

MEASURES:

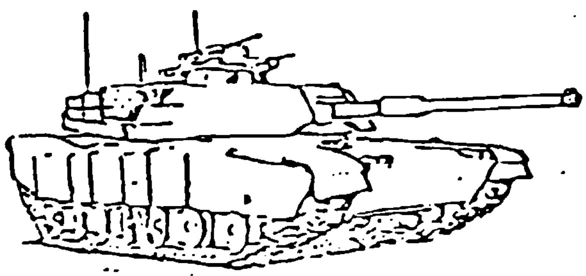
1. Which describes tank after initial stop? (Circle one)

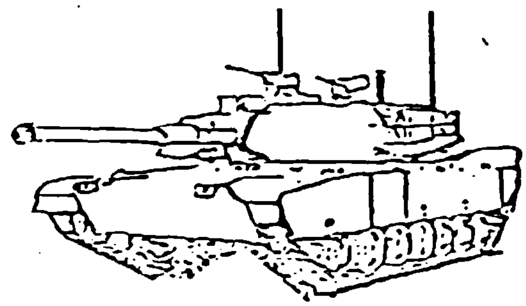
   Maintained Concealment   Intermittent Exposure   Exposed Throughout

2. Number of tape segments visible:

   On turret: __________   On hull: __________

3. Outline portion of tank exposed:





COMMENTS: ____

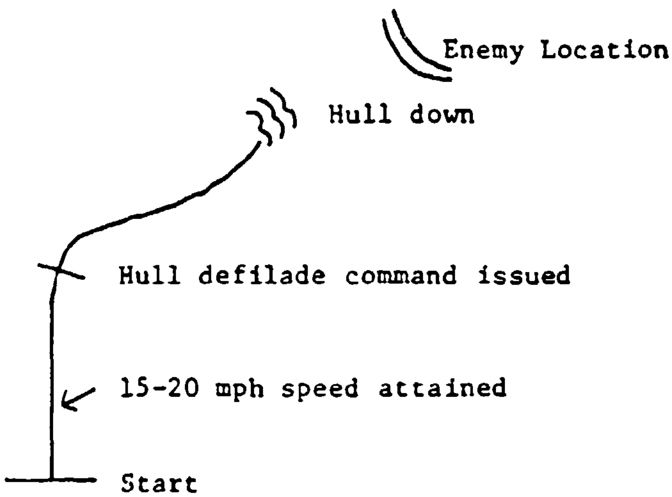
____

____

____

REACT TO TC COMMAND - HULL DEFILADE

TEST CONDITIONS: Terrain allowing tank speed of 15-20 mph and an area approximately 200 meters long and 50 meters wide is required. At least one adequate hull defilade position must be visible during the approach portion of the driving.



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
Tape, adhesive, 1", yellow
1 - binoculars
2 - 2' stakes
20' engineer tape
1 - stopwatch

Personnel:

1 TC
1 Scorer

TEST PREPARATION:

1. Select an enemy location that is visible from the start point and from the hull defilade position. The enemy location should be a minimum of 500 meters from the defilade position.

2. Mark the start point with the stakes and engineer tape.

3. Identify a location for issuing the command. This location should be far enough from the start point to allow the driver to reach 15-20 mph and about 10-12 seconds from the nearest acceptable hull defilade position, and visible from the enemy location. If the location is not marked naturally (such as by a tree), mark the location with stakes and engineer tape.

4. Place two-foot long segments of tape horizontally at intervals along the edge of the front slope and along the middle of the skirts. Tape a second and third row of segments equidistant from the middle row. Repeat the same process for the turret.

TEST ADMINISTRATION AND SCORING (TC):

1. Position the tank, engine off, at the start point.

2. Read the instructions to the driver before mounting the tank.

3. Insure the driver has the hatch closed before starting the test.

4. When the driver reaches the location for issuing the command, announce DRIVER, HULL DEFILADE. Begin timing.

5. If the driver does not reach an estimated 15 mph before the location for the announcement, tell him to speed up.

6. The driver may adjust his position once he arrives at the hull defilade location. Keep track of the number and type of adjustments.

7. When the driver reaches his final position, stop timing and signal the observer.

8. After the driver reaches his final position, look through the GPS extension and adjust the gun if necessary. If you can see the enemy location score Measure 1 YES.

9. Do not assist the driver in moving to or into the defilade position.

TEST ADMINISTRATION AND SCORING (OBSERVER):

1. Select and mark a position at the enemy location. Use this position each time the test is run. If at 500 meters or less, always observe in the same body position, i.e., standing, kneeling or sitting.

2. Observe the tank through the binoculars. When the TC signals that the driver is in the final position, count the number of tape segments visible on the hull and on the turret. Record the number of segments separately for the front and the side.

3. Using the tank pictures on the scoresheet, outline the portion of the tank that is visible.

SCORESHEET

REACT TO TC COMMAND - HULL DEFILADE

TC EVALUATION

Examinee Name: ____________________ Date & Time: ____________________

Trial Number: ____________________ TC: ____________________

Scorer: ____________________

INSTRUCTIONS TO DRIVER: During this test you must react to a command given by the TC. The ____________ (indicate location) is a suspected enemy location. You must operate with the hatch closed and at an initial speed of 15-20 mph. Once I issue you the command I will not assist you in following the command. Do you have any questions?

MEASURES:

1. Was mask clearance obtained? YES NO

2. Speed entering position (Circle one):

   Appropriate Too Slow

3. Stopping (Circle one):

   Smooth Jerky Abrupt

4. Number of adjustments after first stopping:

   Forward __________

   Back __________

   Left __________

   Right __________

5. Time from command to final position: ____________

COMMENTS: ____

____

____

____

SCORESHEET

REACT TO TC COMMAND - HULL DEFILADE

ENEMY OBSERVER EVALUATION

Examinee Name: ____________________ Date & Time: ____________________

Trial: ____________________ TC: ____________________

Scorer(s): ____________________

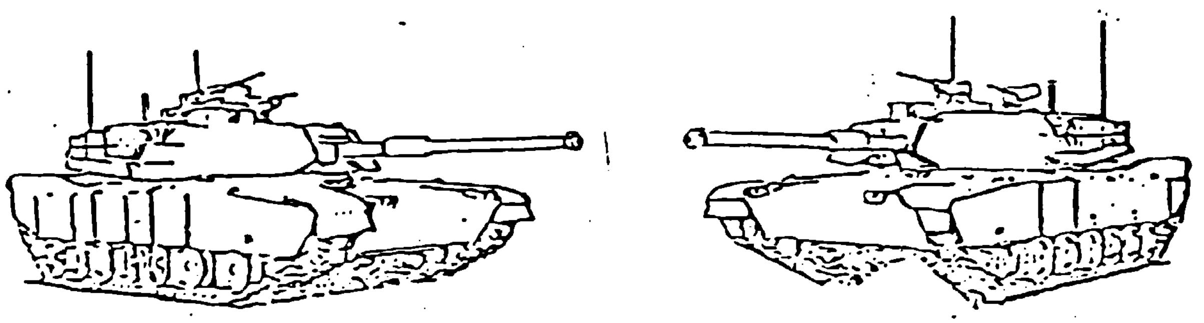
MEASURES:

1. Tape segments visible on hull:

Location	Number
Front	______
Side	______

2. Number of tape segments visible on turret: __________

3. Outline portion of tank exposed:



COMMENTS: ____

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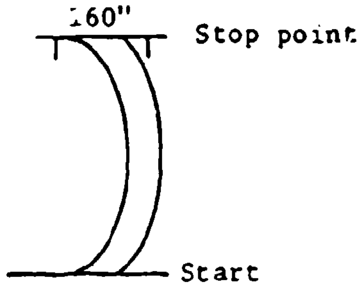
____

ACCELERATION AND STOPPING

TEST CONDITIONS: Test conducted in terrain allowing a hull defilade position. Terrain should be uneven and uphill or inclined if possible. Concealment should be present and terrain may be wooded. A track, approximately 90 meters long, is identified on the ground. This should not be a straight line. A stop point must be identifiable on the ground by the driver. Right and left limits should also be defined at the stop point approximately 160" wide, i.e.,



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
30' engineer tape
8 - 2' stakes
1 - stopwatch
Measuring tape

Personnel:

1 TC
1 Scorer

TEST PREPARATION:

1. Mark the stop point on the ground with engineer tape marking the forward point and right and left limits 160" wide. Secure the engineer tape for the right and lift limits flush to the ground.

2. Mark the start point on the ground.

TEST ADMINISTRATION AND SCORING (TC):

1. Position the tank, engine off, at the start point with the gun tube centered over the front slope.

2. Read the instructions to the driver. If the stop point cannot be seen from the start point, walk the driver to a point where he can observe it.

3. Insure the driver has his hatch locked, transmission in park and engine at tactical idle before issuing the command.

4. Command DRIVER, MOVE OUT and start the time.

5. Stop the time when the tank comes to a halt.

6. Do not allow the driver to adjust the position of the tank once he stops.

TEST ADMINISTRATION AND SCORING (GROUND OBSERVER):

1. Measure the distance forward or back to the stop line from the edge of the front slope.

2. If both tank treads are not within the right and left boundary, measure the distance outside the line. Make the measurement to the outside of the track.

SCORESHEET

ACCELERATION AND STOPPING

TC EVALUATION

Examinee Name: ____________________ Date & Time: ____________________

Trial Number: ____________________ TC: ____________________

Scorer: ____________________

INSTRUCTIONS TO DRIVER: During this test you must move from your present location to a firing position marked by the ________. You must move as rapidly as possible but you will also be scored on the smoothness of your move. In other words, you must not cause the gunner to lose or delay his sight picture. You must stop as close as possible to the ________. Once the tank stops you will not be allowed to adjust the position. When you mount the tank you must close the hatch, start the engine, and place the tactical idle switch on. Leave the transmission in P and the parking brake on until I tell you to move. Move out when I give the command, however, I will not give you a command to stop; you must stop on your own. Any questions?

MEASURES:

1. Accleeration/Deceleration (Circle one):

   Smooth Jerky (Acceptable) Jerky (Unacceptable)

2. Stop (Circle one):

   Smooth Jerky Too Slow Abrupt

3. Time from command to stopping: __________

COMMENTS: ____

____

____

____

SCORESHEET

ACCELERATION AND STOPPING

GROUND OBSERVER EVALUATION

Examinee Name: ______________________ Date & Time: ______________________

Trial Number: ______________________ Scorer: ______________________

MEASURES:

1. Distance from Stop line:

   Over ___________

   Short __________

2. Was tank within boundaries? YES NO

   If NO:

   Distance outside right boundary: ____________

   Distance outside left boundary: ____________

COMMENTS: ____

____

____

____

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